JPRS-USP-90-002
15 MAY 1990

FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Science & Technology

USSR: Space

Science & Technology

USSR: Space

JPRS-USP-90-002

CONTENTS

15 May 1990

Manned Mission Highlights

Space Sciences

Interplanetary Sciences

Life Sciences

Space Engineering

Space Applications

Space Policy, Administration

TASS Report on Fourth EVA

LD0102183990 Moscow TASS in English 1636 GMT 1 Feb 90

[Text] Moscow February 1 TASS—Special TASS correspondent reports from the Mission Control Center:

In accordance with the flight's program Soviet cosmonauts Aleksandr Viktorenko and Aleksander Serebrov completed their fourth space walk on board the orbital complex Mir. They tested a new autonomous vehicle. The vehicle was brought to the station aboard "Kvant-2" module.

It is an apparatus shaped like a knapsack. It has jet engines operating on compressed air.

The vehicle is equipped with autonomous systems of power supply, movement control and radio-telemetric measurements.

The vehicle also has a special juncture for link-up with the dock which the cosmonauts installed during their previous venture into open space.

Aleksander Serebrov today operated the vehicle in open space. Before the space walk the cosmonauts put on their space suits. The flight engineer assumed the place in the vehicle and fastened himself to it. At eleven hours 15 minutes Moscow time [0815 GMT] the hatch of the airlock of Kvant-2 module was open and the cosmonauts walked out into space. At the hatch, the cosmonauts linked up the vehicle to the dock and switched into working position its panels with control instruments.

The tests were conducted in several stages. At first the flight engineer checked the functioning of all the systems of the vehicle, and then undocked.

Controlling the functioning of the engines, Serebrov moved away from the orbital complex to various distances, maneuvered in space, made turns and moved on various planes. He moved away from the hatch as far as to 33 metres.

After completing the planned tests, both cosmonauts returned to the airlock. The crew worked in open space for 4 hours 59 minutes.

The functioning of the vehicle has been tested. Its easy operation and good maneuverability were confirmed.

A safety line was used so that the vehicle remains in touch with the orbital complex.

During all the stages of work in open space, the commander constantly controlled the flight engineer's actions.

Further tests of the autonomous vehicle are planned for February 5. The vehicle will be operated by the crew's commander.

Viktorenko and Serebrov feel well. Work on the orbit continues.

Moscow TV Shows Cosmonaut Using Manned Maneuvering Unit

LD0102114990 Moscow Television Service in Russian 0930 GMT 1 Feb 90

[From "Vremya" newscast; presented by Vladimir Molchanov]

[Text] As I understand it we may now have a linkup with the Flight Control Center. If so, then I hand over to our correspondents Petr Orlov and Sergey Slipchenko:

[Correspondent] Yes, that's so. We are now inside the Flight Control Center and quite honestly it is difficult to take your eyes off the large screen on the right at the Flight Control Center. Right now on the screen you see how Aleksandr Serebrov is some 5 meters from the station in a flying autonomous means of conveyance. They call it simply an armchair. At the moment is has moved away to a distance of 5 meters and has started rising a little bit. The thin cable that you can see is not a cable through which either communications or life support systems run. It is just a winch that insures a cosmonaut against all events so that he doesn't fly away forever into the distance from the station. [video shows wall of Flight Control Center with large central map and displays on each side; correspondent seated with others watching events; screen shows the cable connecting the cosmonaut to the station; views of Flight Control Center personnel at their desks] If you look now at the large map in the Flight Control Center—I'll ask our producers to show us it—look, at the very center of the map, virtually in the center of the Soviet Union, on the border with China, you can see a small dot. This dot is the Mir station, an enormous complex, and next to this dot, at a distance of several meters, is a man, in full isolation, in full autonomy. He is testing the armchair that in the future will help to service this enormous...[changes thought] that has already become an enormous home.

Even here in the Flight Control Center, on the board, it is difficult to read the names of all of the space objects that are docked together at the moment in orbit. They incude both the Mir module, the Mir station, the Kvant module, Kvant-2, Progress-TM and the Soyuz space ship. At the moment the third procedure is already being repeated. In the entire zone these procedures will be repeated, at a short distance, and today, after the cosmonauts have a rest, procedures will be carried out at a great distance, up to 40 meters. Cosmonaut Aleksandr Serebrov will be flying off and trying out this universal means of transporation. [video shows more views of the cable which links the cosmonaut--barely visible—and the ship—also barely visible at the bottom of the screen; more views of the map and personnel inside the Flight Control Center]

Television Coverage of Spacewalk

LD0102143490 Moscow Domestic Television Service in Russian

[Editorial Report] Moscow Television Service in Russian at 1230 GMT on 1 February carries a 20-minute video report from the Flight Control Center on the cosmonauts' activities. Correspondent Petr Orlov says the cosmonauts' extravehicular activity is continuing; they have now been out in space for 4 hours 16 minutes. He speaks to a doctor, who gives details of the cosmonauts' blood pressure readings and says they are in good health.

Correspondent Sergey Slipchenko then interviews (Guy Ilyich Severin), whom he describes as head of the enterprise which made the space armchair. (Severin) says the need for an autonomous unit for cosmonauts to move around in space was identified when S.P. Korolev was alive and in charge of the space program, and he continues: "In 1965, the works collective embarked on building the first systems for movement and maneuvering of cosmonauts. Such a system was built and tested in 1966, and we planned to test it on craft of the 3KD series, or Voskhod-2." He then states that they were, however, ahead of their time, and the system could not be located on the spacecraft. And Korolev's untimely death also had its influence.

Orlov then talks to a communications officer, who says that Serebrov is still in the Sredstvo Peredvizheniya Kosmonavta [SPK], the correct name for the flying armchair, with Viktorenko near the exit hatch monitoring operations. The SPK is working fine. Television pictures should be coming in at 1547 Moscow time. The communications officer tells the cosmonauts that live television transmission is in progress, and that viewers are cheering for them; the cosmonaut cracks a joke in reply. Following this Slipchenko speaks to (Severin) again. He says that the SPK is neither a chair nor a bike, but a mini-spacecraft. Asked if it is worth the money spent on it, (Severin) says that too often in Russia's and the Soviet Union's past they have been ahead of the world with a new development, and have given it up only to see it taken up in other countries, and then had to try to catch up again. He is happy with the performance of the SPK so far, and notes that Serebrov's comments have been positive.

Orlov, back at the armchair, which he showed in the 1045 bulletin, says that it works on compressed air. The cosmonauts added a remote control switch for the television camera mounted off the right shoulder. Television pictures from space should be coming up soon. Serebrov is to go 20 meters from station, using high-speed operation [forsirovannyy rezhim].

The video then shows the control room as the cosmonauts are heard counting off distance telemetry. Slipchenko talks to (Severin) again, and says Serebrov is going further than the 20 meters planned. Serebrov reaches 25 meters. Orlov points out the controls on the right-hand arm rest used to fix position in space. As the reportage ends, Serebrov is situated 33 meters from the station according to telemetry, but no television pictures are coming in.

Report on Conclusion of Fourth EVA

LD0102165290 Moscow Domestic Service in Russian

[Editorial Report] Moscow Domestic Service in Russian at 1030 GMT on 1 February broadcasts a report by correspondent Vladimir Bezyayev from the Flight Control Center on today's space walk. Bezyayev reports that Viktorenko and Serebrov's trial is the first means of moving a spaceman in open space. The test was conducted by Serebrov, flight engineer, while Viktorenko took video pictures. Bezyayev reads out figures at the Flight Control Center: time of stay in outer space was 4 hours, 46 minutes. First Serebrov took small steps from the station, only moving 5 meters, then the main modes of movement of the flying armchair were tried out.

Bezyayev says that with the appearance of massive objects in orbit there came the need for repair and installation work, and hence the need of means of moving about. "Designers from Zvezda Machine-Building Works started making the flying armchair and today we can congratulate them on their debut. Its mass is 200 kg, it can work in space 6 hours, the same duration for which the new space suits—the Orlan DMA—are designed for work in open space. Now we see that they have been in open space for 4 hours, 49 minutes and everything is going according to plan. The next walk in space is planned for 5 February."

Further Comment on EVA, Comparison With U.S. MMU

LD0102163390 Moscow Domestic Service in Russian

[Editorial Report] Moscow Domestic Service in Russian at 1100 GMT on 1 February broadcasts an "update on space walk" in which the announcer says:

"As we have already reported, the crew of the Mir orbital complex is now conducting tests on an autonomous means of conveyance for cosmonauts. Here are the details from our special correspondent at the Flight Control Center Vladimir Bezyayev."

Bezyayev says: "Aleksandr Viktorenko and Aleksandr Serebrov are continuing to test the autonomous means of conveyance for cosmonauts.... This flying armchair is being directly tested by Aleksandr Serebrov. Now the Flight Control Center has given Aleksandr Serebrov a few minutes of breathing-time. The work is going ahead intensively. The main stage in the testing has now started. In keeping with the program, there should be tests on short distances away from the station at high speed. I shall explain that this flying armchair has two operation speeds—an economical one and a high speed one.

"It is probably appropriate to describe this means of conveyance for cosmonauts, all the more so, since the journalists here have just been introduced to the developers of this technology. We have learned very many interesting things. I shall try to convey these to you, too. The fact is that in principle it would seem to be the Americans who take precedence in using various transport installations in space. Testing was carried out in 1984 on Challenger, which was destroyed 2 years later—but it turns out that we have been developing a facility like this for a long time. When it was not needed the work was stopped temporarily and then resumed in later years.

"At the present time we have a means of conveyance for cosmonauts. How does it differ from that of the Americans? First, ours is more powerful. Its tractive and loading power is one and half times greater. That is, with its aid one can transfer more cargoes, and that is very important."

Bezyayev adds that there is such a concept as a speed specifications reserve. "That is, if all the valves are fully opened—and the operating body of this flying armchair is ordinary compressed air—then at the end of acceleration it will reach a speed of 30 meters per second. The American means of conveyance can only do 20 meters per second."

He says tests are now being carried out on the winch, not for physical insurance, "but for moral insurance for the cosmonauts. Evidently the winch will still be used directly at many of the exits of the Mir orbital complex. Now they have told us that Buran will be equipped with such means of conveyance as well. Spaceships of the Buran and Shuttle types have many possibilities for maneuvers in orbit. There the winch will simply not be necessary. The station flies on such a fixed course and can only allow itself rotation."

Fifth EVA Performed 5 Feb

LD0502091690 Moscow TASS in English 0837 GMT 5 Feb 90

[By TASS special correspondent R. Kuznetsova]

[Text] Moscow February 5 TASS—Soviet cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov, now manning the Mir orbital complex for almost five months stepped out into open space today. The hatch opened at 9 hours 8 minutes Moscow time. This is the fifth exit of members of the current expedition into open space.

The crew will continue testing the cosmonauts' travelling chair, or as they dubbed it "space motorcycle," outside the complex in different regimes. The first test was carried out on February 1.

The "space motorcycle" and the special pressurised suit, fitted out with autonomous means of communication, telemetry and power source, were delivered to the complex by the special supply module Kvant-2 on December 6, 1989. The launching of the module was put off twice. First in April 1989, when the complex was manned by the crew of the fourth principal expedition—Alexander Volkov, Sergey Krikalev and Valery Polyakov. Delays in the construction of the supply module compelled specialists and scientists to revise their initial plans. It was decided to operate the complex without a crew for a few months in order to save money and prepare more thouroughly for a new stage of work on board Mir.

Later the supply module was to be orbited in mid-September of last year. The launching was put off because certain faults were found during ground tests in the Kurs system, intended to ensure the putting of the module on the needed orbit and its closing in with the complex.

The "space motorcycle" is designed primarily for checking systems of different space objects—from Sputniks to Buran reusable spaceships. It allows a cosmonaut to maneuver freely and circle the orbital complex, to depart from it and rotate around its own axis.

TASS Report on Fifth EVA

LD0502173290 Moscow TASS in English 1654 GMT 5 Feb 90

[Text] Moscow February 5 TASS—TASS reports from the Flight Control Center.

Aleksandr Viktorenko and Aleksandr Serebrov continue to work onboard the Mir orbital research complex.

Under the flight program they have made their fifth space walk and completed flight-testing the cosmonauts' autonomous movement unit, and the new airlock and egress system of the specialised Kvant-2 module.

The crew left the station at 9 hours 8 minutes Moscow time. Viktorenko's testing program included operating the autonomous movement unit at different regimes, moving to a distance of 45 meters from the orbital complex. The crew commander praised the performance of the unit.

During the space walk the commander measured the radiation background around the station by mounting a portable automatic spectrometer on the front part of the unit. He made several measurements of the spatial and energy characteristics of the X-ray and gamma-radiation at given orientations and at different distances from the orbital complex.

Completing the planned assignment, the crew returned inside the station. They stayed in outer space for 3 hours 45 minutes.

So the crew's assignnment for the fifth major venture outside the complex has been fully performed.

The successful testing of the space suits of the new modification, of the unit for cosmonauts' autonomous movement, and of the new airlock compartment open up

broad opportunities in terms of creating and operating manned systems in near-earth orbit for scientific and economic purposes.

Destructive Reentry of Progress M-2 Cargo Spacecraft

LD0902103190 Moscow TASS in English 1005 GMT 9 Feb 90

[Text] Moscow February 9 TASS—By TASS correspondent from the Mission Control Center:

The Progress M-2 automatic cargo spacecraft, which delivered more than 2.5 tonnes of various cargo to the orbital complex Mir, has finished its mission. At 05.33, Moscow time, [0233 GMT] today, the spacecraft separated from the manned orbital complex, transferred to a descent path, entered the dense layers of the atmosphere and ceased to exist.

Radio engineering systems for the approach of spacecraft with the use of a relay satellite in geostationary orbit were tested during the cargo spacecraft's separation from the orbital station.

Aleksandr Viktorenko and Aleksandr Serebrov continue their work in orbit. This week their work included medico-biological and astrophysical research. The cosmonauts also tried out a new shower installation that is available in the Kvant-2 module.

The experiment, started on the Gallar installation on February 6, is being continued in order to obtain a semiCOnductor material, gallium arsenide, in microgravitation conditions. The full cycle of this technological process lasts 120 hours.

According to medical control data, the two cosmonauts are in good health and are feeling well.

Preparations are now under way at Baykonur cosmodrome to launch a Soyuz TM-9 manned spaceship. Lift-off is scheduled for 09.16 Moscow time, [0616 GMT] on February 11.

Crew Chosen For Next Mission

LD1002105990 Moscow TASS in English 1051 GMT 10 Feb 90

[Text] Baykonur February 10 TASS—Anatoliy Solovyev and Aleksandr Balandin will be the crew to fly into space aboard the Soyuz-TM spaceship on Sunday on a flight to the orbital station Mir, a State Commission spokesman told journalists at a news conference today.

The new crew will take the place of Aleksandr Viktorenko and Aleksandr Serebrov and will work in orbit for about six months.

Speakers at the news conference also pointed out that, for the first time in Soviet cosmonautics, incomes from the results of the flight are expected to exceed by far the spending on the spaceship's launch.

Up to 25 million rubles of net profit are expected to be obtained, mainly resultant of the utilization of the "Kristall" [Crystal] technological module.

The module is scheduled to be launched on March 30 and to dock with the orbital complex on April 7-8.

Today Solovyev and Balandin will go to bed at 18.00, Moscow time. The crew will begin pre-launch procedures at 02.00 on February 11.

New Mir Module Will Make Mission Profitable

LD1002211590 Moscow Television Service in Russian 1530 GMT 10 Feb 90

[Video report from Baykonur cosmodrome by correspondents Slipcheno and Pankratov; from the "Vremya" newscast]

[Excerpt] [Passage omitted] [Unidentified correspondent] They [orbital station Mir] will receive the new module and by summer they should obtain about 100 kg of crystals and ultrapure proteins for vaccines and serums, and hundreds of photographic films for the cartographers.

The [news conference] statement by the Space Industry Minister Oleg Nikolayevich Shishkin, could be called sensational.

[Begin Shishkin recording] Your flight, the results of your flight, will for the first time bring to Earth, as it were, information and materials which will be worth much more than the cost of the launch and your work in space. In other words, you will begin to make a profit. [end recording]

[Unidentified correspondent] Experts estimate the cost of this expedition at about 80 million rubles, but 105 million's worth of production will be obtained in space: a profit of 25 million is expected. And that figure could rise considerably if terrestrial industry make good use of the cargo from space. The launch of the spaceship Soyuz TM-9 is scheduled for 11 February, at 0916 GMT Moscow Time. Central Television is planning a direct report on the First All-Union Program. [video shows the process of obtaining new crystals, the Kristall module, scene at Shishkin news conference, cosmonauts shown addressing it].

Launch of Soyuz TM-9

LD1102062490 Moscow TASS in English 0622 GMT 11 Feb 90

[Text] Moscow February 11 TASS—The spaceship Soyuz TM-9 was launched from Baykonur Cosmodrome at 09:16 [0616 GMT], Moscow time, today. Anatoliy Solovyev is mission commander and Aleksandr Balandin is flight engineer.

The crew are to dock the spaceship with the Soviet orbital complex Mir and then take the place of the crew

of the fifth main expedition—Aleksandr Viktorenko and Aleksandr Serebrov who have been working in orbit for the sixth month and who are expected to return to Earth on February 19.

Soyuz TM-9 Trajectory Correction

LD1202114990 Moscow TASS in English 1141 GMT 12 Feb 90

[Text] Moscow February 12 TASS—A TASS correspondent reports from the Flight Control Center:

The spaceship Soyuz TM-9, manned by Anatoliy Solovyev and Aleksandr Balandin, is continuing its flight towards the scientific research complex Mir.

The crew checked the efficiency of the spaceship's onboard systems and the compartments' airtight seal on Sunday. Two long approach maneuvers have been made.

An additional correction of the spaceship Soyuz TM-9's trajectory was made today. The parameters of its orbit are now as follows:

Maximum distance from the earth's surface—338 km,

Minimin distance from the earth's surface—297 km,

Period of revolution—90.8 minutes,

Inclination—51.6 degrees

Aleksandr Viktorenko and Aleksander Serebrov have spent a total of 160 days in a near-Earth orbit. Today's program envisages a number of scientific-technological experiments. They will also make preparations to meet the new crew.

In accordance with the Gallar unit space materiology studies program, the cosmonauts completed a technological experiment, begun on February 6, to obtain the semiconductor material gallium arsenide in microgravitation conditions.

The cosmonauts Viktorenko, Serebrov, Solovev and Balandin feel fine. The Soyuz TM-9 spaceship is planned to dock with the Mir complex at 09:40, February 13.

Soyuz TM-9 Docks With Mir Complex

LD1302072690 Moscow Domestic Service in Russian 0700 GMT 13 Feb 90

[Excerpt] The docking of the Soyuz TM-9 with the Mir orbital complex was carried out some minutes ago. Vladimir Bezyayev, our special correspondent at the Flight Control Center, gives more details.

[Bezyayev] Yes, this took place at 09 hours, 37 minutes, 48 seconds [0637 GMT]. The docking passed astonishingly smoothly, without a hitch. [passage omitted]

TASS Outlines Mission Program

LD1302103190 Moscow TASS in English 0957 GMT 13 Feb 90

[Text] Moscow February 13 TASS—The Soyuz TM-9 space ship, with two cosmonauts on board, docked with the Mir space station at 9:38 Moscow time today.

Soyuz TM-9 mission commander Anatoliy Solovyev and flight engineer Aleksandr Balandin joined Aleksandr Viktorenko and Aleksandr Serebrov aboard Mir.

After nearly a week of joint experiments, Viktorenko and Serebrov will return to earth on the Soyuz TM-8 craft.

Solovev and Balandin will stay five and a half months on Mir to continue experiments begun by previous crews, geophysical and astrophysical research and biotechnology projects.

In April, the Kristall (crystal) specialised technological module carrying equipment for astrophysical, geophysical and biotechnological research will dock with Mir.

Solovyev and Balandin will use the new hardware to conduct research into various materials and for pilot manufacture of improved-quality semiconductors for the electronics industry.

Mir systems are working normally, according to Mission Control.

The crew has begun implementing the flight program.

Cosmonauts Work on Biological Experiment Program

LD1402180690 Moscow TASS in English 1145 GMT 14 Feb 90

[Text] Moscow February 14 TASS—Four Soviet cosmonauts continue working aboard the Soviet Mir station for the second day.

The scientific part of the joint flight includes medical, biological and biotechnological experiments, Anatoliy Solovyev and Aleksandr Balandin continue to acquaint themselves with the station's equipment.

The cosmonauts are already working on the electrophoresis installation Ruchey as part of the biotechnological research program. Their aim is to work out basic techniques to [purify] insulin in conditions of microgravitation.

The new crew that arrived at the Mir station is carrying out a series of medical experiments to assess the state of the human organism at the initial stage of adaptation to weightlessness and to define the efficiency of preventive means used during this period.

Aleksandr Viktorenko and Aleksandr Serebrov who are preparing to return to earth will train using the pneumatic vacuum suit Chibis.

The cosmonauts have started experiments with biological material delivered to the Mir station by "Soyuz TM-9." It includes higher plants, animal and plant tissue cultures and amphibia.

Cosmonauts Viktorenko, Serebrov, Solovyev and Balandin feel fine.

Joint Crews Continue Experiments

LD1602144890 Moscow TASS in English 0958 GMT 16 Feb 90

[A TASS corresondent reports from the Flight Control Center]

[Text] Moscow February 16 TASS—The joint flight of Cosmonauts Viktorenko, Serebrov, Solovyov and Balandin is continuing normally.

The crew of the "Mir" orbital complex are busy on several experiments today. They are trying to perfect the technology of purifying medical preparations in microgravitational conditions by means of the "Ruchey" electrophoresis installation.

The cosmonauts also carried out the "Resonance" experiment to determine the dynamic characteristics of the orbital complex, making up a complicated space system.

The first series of experiments to study the influence of open space factors on the structure and properties of ferromagnetic materials were started by means of "Ferrit" equipment, installed this January on the outside surface of the "Kvant-2" module.

The materials study program, which will be carried out by means of the "Gallar" installation, includes an experiment to obtain a monocrystal of gallium arsenide.

In view of their impending return to the earth, Aleksandr Viktorenko and Aleksandr Serebrov today showed Anatoliy Solovyov and Aleksandr Balandin, who will replace them on the orbit, some specific methods of controlling the complex's movement.

The work on the orbit is proceeding according to the fixed schedule. The cosmonauts feel well.

Viktorenko and Serebrov Prepare for Return

LD1702124990 Moscow TASS in English 1203 GMT 17 Feb 90

["Four Soviet Cosmonauts About To End Joint Work in Orbit"—TASS headline]

[Text] Mission Control Center February 17 TASS—The joint flight of four Soviet cosmonauts aboard the research orbital complex Mir is drawing to an end

Today Aleksandr Viktorenko and Aleksandr Serebrov will check the control systems of the Soyuz TM-8 spacecraft in which they will return to earth.

They will also hold training sessions with the use of the Chibis pneumatic vacuum space suit which simulates terrestrial gravitation.

Anatoliy Solovyov and Aleksandr Balandin, members of the sixth main expedition, will engage in preparing scientific equipment for forthcoming experiments and carry out medical control examinations.

Biotechnological research on the Ruchey and Biokrist installations are being completed today. Final operations will be performed to grow monocrystals of various protein compounds in zero gravity and yet another experiment will be carried out to test the technology to purify medicinal preparations by an electrophoresis method.

The first of a series of biological experiments with the utilization of scientific equipment, made in the United States under a commercial agreement, has also been completed.

According to reports from orbit, the flight is proceeding according to program. The cosmonauts are in good health and are feeling well.

Viktorenko and Serebrov Return to Earth in Soyuz TM-8

LD1902115590 Moscow TASS in English 1129 GMT 19 Feb 90

[Text] Arkalyk, Kazakhstan February 19 TASS—TASS special correspondent Andrey Filippov:

The Soyuz TM-8 spacecraft touched down in Soviet Kazakhstan at 7:36 Moscow time today, sending up a huge cloud of snow, some 55 kilometers northeast of the city of Arkalyk.

Cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov safely returned to earth after spending 166 days aboard the Mir space station.

Weathermen refused to okay the touch down for twenty-four hours because temperatures fell to minus 30 degrees Centigrade and a biting wind swept the area.

Finally, there was an "opening" over Arkalyk and the mission control decided to land the craft there.

Rescue teams spotted the landing craft when it was hovering several kilometers above the earth. By half-past-seven several helicopters with doctors and reporters had arrived at the expected landing site.

The craft smoothly nears earth, swinging under the cupola of its parachute. Soft landing motors ignite, and finally the pair of cosmonauts emerge from the hatch, stepping down on snow.

Medics intervened just seconds after reporters flocked to the cosmonauts, leading them to a warm tent for "early" check ups.

"Our cargo includes semiconductor crystals and bio preparations," Aleksandr Viktorenko told TASS.

It took about an hour to unload the landing craft. The crew and cargo were then transferred to Arkalyk. Viktorenko and Serebrov flew to Moscow.

Cosmonauts Redock Soyuz TM-9 Spacecraft

LD2102101290 Moscow TASS in English 1005 GMT 21 Feb 90

[Text] Moscow February 21 TASS—TASS special correspondent reports from the Flight Control Center.

Cosmonauts Anatoliy Solovyev and Aleksandr Balandin redocked the Soyuz TM-9 vehicle from the astrophysical module Kvant to the axial docking lock of the station's (transfer compartment).

Before the redocking operation, the crew commander and engineer went over to the transport vehicle and locked the hatches. The space vehicles were separated at 6 hours 56 minites Moscow time [0356 GMT]. The crew used manual controls to fly around the orbital complex, close in and accomplish the docking.

The Soyuz TM-9 vehicle remained in autonomous flight for 19 minutes.

Work is being continued on board the Mir orbital research complex.

Anatoliy Solovyev and Aleksandr Balandin are feeling well.

Cosmonauts Begin Crystal Growth Experiment

LD2602094690 Moscow World Service in English 0800 GMT 26 Feb 90

[Text] The Soviet crew on the orbital complex Mir has begun an experiment with growing semiconducting crystals in conditions of weightlessness. The superpure substances are produced in the automatic device Gallar. The cosmonauts, Anatoliy Solovyev and Aleksandr Balandin, are keeping a close watch on the production process. The bulk of the experiments will later be conducted on the research module Kristall.

Specialists believe that the materials produced on orbit will bring a profit of 25 million rubles.

Heat Control Panels Come Loose From Soyuz TM-9

LD2702143490 Moscow Television Service in Russian 1800 GMT 23 Feb 90

[Video report by correspondent Slipchenko from the Flight Control Center; from the "Vremya" newscast]

[Text] We have told you all manner of things in the past in our space r portages, for example—unforeseen situations in orbit. Today, our correspondent reports on such a situation.

[Slipchenko] Anatoliy Solovyev and Aleksandr Balandin are preparing to receive a routine Progress craft. For this purpose, they cleared a docking port and redocked their TM-9, as you saw yesterday. [video shows Mir complex from space, then head-on view of an approaching spacecraft, with what looks like three rectangular pieces of cloth flapping about at rear end of it] But what is this? When the camera showing the approaching craft was switched on, this is what was seen in the Flight Control Center—this usual view of a Soyuz, a quite standard Soyuz. But in addition to the aerials and optical instruments, there are three strange shapes on the Soyuz as seen on screen. Nothing has broken off, nothing has caught fire or exploded, there are no rags and tatters. But the panels, which are attached on Earth and held by clips, though they are all in one piece, have broken loose from their fastenings and straightened out in space under their own elasticity.

[V.D. Blagov, deputy flight controller, identified by caption] Why do we apply these covers to the descent module and other compartments of the Soyuz? In order to stabilize the outflow and inflow of heat. [Video shows Soyuz inside building, mounted in framework, with cover visible on spherical descent module at end]

[Slipchenko] Is it possible that some part of condensation could occur on the descent module or other part of the spacecraft which could affect the electric circuits, or contacts, or any of the pyrotechnics?

[Blagov] If the air temperature in the descent module or any metal structural element inside the cover and in contact with the air is allowed to fall below the dew point, that is about ten or nine degrees, certainly moisture will condense on these surfaces. We must not permit this, because this is not a very pleasant situation. If moisture gets into the instruments, well, some of them are sealed and protected, but others are not, so it would be hard to predict how they would continue operating. This places certain limitations on using the orientation regimens. So we are now selecting the minimum number of regimens. So in that sense, we are subject to limitations. But we can keep going indefinitely by keeping the temperature within set limits. But we have to pay for this in some way, for example, by reducing the number of some experiments which require other forms of orientation, which we cannot now use. In this connection, of course, we shall have to take radical measures of some kind to restore everything to its original condition. This is something which, it appears, will require the cosmonauts to go out into space. [video shows Slipchenko and Blagov talking, ends with final shot of the Soyuz approaching the docking port]

'Progress M-3' Cargo Ship Launched

LD0103015490 Moscow TASS International Service in Russian 0122 GMT 1 Mar 90

[Text] Moscow, 1 Mar (TASS)—In accordance with the program of further work for the "Mir" scientific research complex, the automatic cargo ship "Progress M-3" was launched in the Soviet Union on 1 March 1990 at 0211 Moscow time [2311 GMT].

The purpose of launching the vessel is to deliver consumable materials and assorted cargo to the "Mir" manned space station.

The vehicle "Progress M-3" has been placed in an orbit with the following parameters:

—maximum distance from the earth's surface: 245 km;
—minimum distance from the earth's surface: 188 km;
—period of revolution: 88.6 minutes;
—inclination: 51.6 degrees.

According to the telemetric information received, the onboard systems of the automatic cargo ship are working normally.

Progress M-3 Docks With Mir Complex

LD0303025190 Moscow TASS International Service in Russian 0156 GMT 3 Mar 90

[Text] Moscow, 3 March [TASS]—The docking of the cargo vessel Progress M-3 and the Mir manned space station took place at 0405 Moscow time [0105 GMT] on 3 March 1990.

The mutual tracking, approach, mooring, and docking were carried out with the help of the automatic equipment on board. These processes were monitored [kontrolirovalis] by the Flight Control Center and also by cosmonauts Anatoliy Solovyev and Aleksandr Balandin.

The Progress M-3 craft docked with the complex on the side where the module Kvant is located. Fuel for the station's consolidated propulsion unit, food, water, equipment, apparatus, and mail have been delivered into orbit [to the space station].

According to telemetry information and crew reports, the manned complex's on-board systems are working normally.

Anatoliy Solovyev and Aleksandr Balandin are feeling fine.

Solovyev and Balandin Continue Experiments Aboard Mir

LD0703115490 Moscow TASS in English 1152 GMT 7 Mar 90

[Text] Moscow March 7 TASS—TASS special correspondent reports from the Flight Control Center:

Anatoliy Solovyev's and Aleksander Balandin's work program included unloading the automatic Progress-M-3 transport craft, which brought new equipment to the orbit. They will also carry out several technological, technical and biological experiments.

In keeping with the piloted complex's maintenance service plan, the crew installed a new set of storage batteries on the station and replaced separate elements in the electric supply system.

The cosmonauts carried out a smelt to obtain gallium arsenide, a special semi-conductor material.

A series of experiments to check the influence of open space on physico-mechanical properties of polymer and composite materials was carried out. The working bloc of the equipment used was installed on the external surface of the Kvant-2 module by the previous crew.

Experiments are being continued to measure and evaluate the levels of ionizing cosmic radiation in near-earth space. The obtained data is used to control and forecast the radiological situation on the complex's flight route.

A long-term biological experiment has been started on the Mir complex to study the influence of space flights on the development of a bird organism and its heredity. Used for the purpose is the Incubator-2 equipment, developed jointly by Soviet and Czechoslovak specialists. The experiment will be carried out on a Japanese quail.

Work on the orbit is proceeding in keeping with the approved schedule. The cosmonauts feel well.

Cosmonaut Says Heat Insulation Damage No Threat

LD0903203490

[Editorial Report] Moscow Domestic Service in Russian at 1600 GMT on 9 March carries a three-minute communications session with the Mir space complex conducted by presenter Vladimir Bezyayev.

Bezyayev asks cosmonauts Anatoliy Solovyev and Aleksandr Balandin what a holiday means for them. The cosmonauts reply that they always have plenty of work to do, especially since a transport spacecraft arrived only recently and needs to be unloaded. However, they are not experiencing any stress.

Bezyayev then asks: "You have said that there are no stresses. But here there was a most serious stress for everybody when redocking took place and they saw that the protective skin of the ship had become dislodged and was dangling. Does a threat to your health not arise in connection with this, a threat to the orbital station? And, generally, how do you evaluate this situation?"

One of the cosmonauts replies: "This is a situation which generally requires attention, of course. But it probably is not all that serious. Personally for us, no extra burden or

stress is arising. Probably it means extra work for Flight Control Center [FCC], because it is necessary to orient the entire installation in such a way that the ship—and the part of it on which the vacuum-shield heat insulation became dislodged—does not get too warm or too cold. Therefore, the corresponding orientation is required. This task befalls the FCC. There are no other specifics for us. I think that we perceived this as already accomplished, so there are no particular anxieties for us. Maybe, there simply will be some extra work for us".

Bezyayev asks: "But, in principle, one cannot exclude the variant that you will have to do a space walk? Is that so?"

The same cosmonaut responds: "We are prepared for that work. Therefore, there is nothing too special about that either."

Providing background information in the studio, Bezyayev says: "I will tell you immediately that such situations have already arisen in orbit for U.S. astronauts and were resolved successfully. But now Anatoliy Solovyev and Aleksandr Balandin have started one most interesting biological experiment, which we will tell you about in detail in the next few days. And in two days time, the second month of flight for Anatoliy Solovyev and Aleksandr Balandin will begin."

Cost of Previous Mission to Mir Recouped

LD1203103890 Moscow TASS in English 2206 GMT 11 Mar 90

[By TASS Correspondent Andrey Filippov]

[Text] Moscow March 12 TASS—According to preliminary estimates, the expenditures for the 166-day flight of the fifth expedition to the orbital station Mir, amounting to some 90 million rubles, have been recouped. This has become possible mainly due to scientific and technological experiments carried out during a prolonged space flight.

Cosmonauts Alexsandr Viktorenko and Aleksandr Serebrov who returned to the ground on February 19 reported to the State Commission on Sunday. It was noted at the state commission's meeting that for the first time in the practice of space flights, the smelting of semiconductor crystals for the electronic industry was conducted on board the spacecraft for several weeks. It should be noted that the smelting was made at the record temperature of 1,200 degrees Centrigrade.

Biological crystals for the needs of the medical science were grown on board the orbital station Mir for several months. This project was also implemented for the first time. First reports about the ecological situation on the Earth were received from board the station.

An experiment commissioned by the American Payload Systems was successfully fulfilled on a commercial basis. Samples of space equipment were successfully flight tested in open space during the expedition.

The new orbital module "Kvant-2" was linked up to the basic station Mir.

At the same time the cosmonauts described a number of problems without whose solution the efficiency of space flights cannot be enhanced.

Because of ergonomic drawbacks of the station, the crew at times had to spend up to 80 percent of their working time to prepare their work place and fix their position. There are no adjustments for fixating the cosmonauts in the zones of work while fulfilling some or other experiments.

Despite complaints of numerous crews the equipment is not being refined.

Some of the problems posed by cosmonauts will shortly be resolved. Others will await their solutions for "objective reasons," according to representatives of the scientific-production amalgamation "Energiya".

Semenov Discusses Upcoming Operations on Mir

LD1503191790 Moscow TASS in English 1831 GMT 15 Mar 90

[Text] Moscow March 15 TASS—The fifth space expedition to the Soviet orbital station Mir was economically profitable, Yuriy Semenov, general designer of the Scientific-Production Association Energiya told a news conference held at the Soviet Foreign Ministry press center today.

The news conference was devoted to the results of the 166-day flight of Soviet cosmonauts Aleksander Viktorenko and Aleksander Serebrov.

Semenov said that the Soviet Union was planning to expand the station's scientific research capabilities over the next few years. One more technological module "Kristall" is to be launched to the Mir station on April 9. Semenov called the new module a microplant that will manufacture crystals in outer space.

Semenov also said that the Soviet Union was planning to put an ecological complex into orbit next year. The ecological complex will help resolve the global planetary task of human survival. The complex will consist of two monitoring modules: "Spektr" and "Priroda."

Semenov also spoke about the Energiya-Buran universal booster transport system. He emphasised that this system was to open new space horizons in the future. It will be indispensable to the development of universal and large-size orbital complex in future. The technical abilities of this system will be tested during Buran's experimental flight in 1991. Buran is to dock with the station, put a payload into orbit and return it to earth.

The fifth space expedition to the Mir station was a turning point in the transition of the Soviet space

industry to work in new economic conditions. The mission of Anatoliy Solovyov and Aleksander Balandin, who are now working on the Mir station, will also bring a tangible profit.

Cosmonauts Replace Mir Control Computer

LD1703230790 Moscow Domestic Service in Russian 0700 GMT 17 Mar 90

[Text] News from space: Today and tomorrow are working days on board the Mir complex. The deviation from the usual five-day working week is connected with the replacement of one of the computers in the station's motion control system by a more sophisticated one. According to recommendations by specialists, these complex and labor-intensive operations should be completed within quite a short time. The cosmonauts will rest on weekdays.

According to reports from the crew and telemetry information, everything is in order on board. Anatoliy Solovyev and Aleksandr Balandin are well and feel fine.

Crew Produces Gallium Arsenide in Gallar Unit

LD2303111190 Moscow TASS in English 0945 GMT 23 Mar 90

[Text] Moscow March 23 TASS—By TASS correspondent Rena Kuznetsova:

The first smelts to obtain gallium arsenide, a semiconductor material, have been carried out by means of the Gallar installation on board the Soviet Mir obrbital complex.

This work, performed by crew members Anatoliy Solovyov and Aleksandr Balandin, continues the extensive technological program carried out by the previous crew—Aleksandr Viktorenko and Aleksandr Serebrov. They staged twelve experiments linked with the production of semiconductor materials during their 166-day flight.

These experiments are mainly intended to elaborate the basic processes for semiconductor crystallization needed to manufacture experimental batches of gallium arsenide, zinc oxide and cadmium sulphide in outer space. These crystals will later be used to make various instruments. According to specialists, principles have been developed for the production of silicon film used in super-large [integrated circuits].

Equipment, incorporating cadmium sulphide monocrystals, can already been seen in experimental laboratories of the USSR Electronics Ministry, for instance a laser kinescope. The monocrystals were obtained in outer space and there are no terrestrial analogues as regards technical performance.

Specialists believe space technologies to be very promising. They may yield an annual economic effect of 400-800 million rubles.

Yuriy Semenov, general [designer] of the Energiya Scientific Production Association, told TASS that the "Kristall" technological module was to be launched on April 9. It will be a sort of micro-plant for the production of crystals in outer space.

Cosmonauts Install New Kap-350 Camera

LD2703131190 Moscow TASS in English 0931 GMT 27 Mar 90

[By TASS correspondent from the Mission Control Center]

[Text] Moscow March 27 TASS—Soviet cosmonauts Anatoliy Solovyev and Aleksandr Balandin have now spent six weeks aboard the Mir orbiting station.

Today they will carry out technical, geophysical and medico-biological experiments, as well as compile an inventory of the life support system's stocks.

In accordance with the program for medical research, the two cosmonauts will undergo a medical checkup to assess the state of their internal organs with the help of ultrasound.

They are also planning the "Rezonans" experiment to estimate the dynamic characteristics of the orbiting station.

The cosmonauts have pumped fuel, brought by the automatic cargo ship "Progress M-3," into the tanks of the [consolidated] power plant of Mir.

They are continuing to re-equip the station with additional devices and installations. On Monday, the cosmonauts assembled a new stationary camera Kap-350 for geophysical research in the Kvant-2 module. The camera will be tested today together with the station computer.

The flight is going on normally and the cosmonauts are feeling well.

Mir Station Marks 1,500 Days in Space

LD3003184190 Moscow TASS in English 1036 GMT 30 Mar 90

[Text] Mission Control Center March 30 TASS—The Soviet Mir orbiting station has spent 1,500 days in space.

Cosmonauts Anatoliy Solovyev and Aleksandr Balandin have been recently testing motion control systems in the major unit and orbital modules in the general Mir contour.

According to plan, the cosmonauts underwent medical checkups to estimate the reaction of their cardiovascular systems to physical strain.

Along with re-equipping the station, the crew continues to fulfil its scientific program. Today they will carry out a series of experiments to estimate the influence of outer space on physical and mechanical characteristics of

various materials, samples of which are installed on the outer part of the Kvant-2 module.

They will also study the ionosphere and the upper atmospheric layers.

According to the medical check-up, the cosmonauts are feeling well.

Cosmonauts Study Space Effects on Materials

LD0604213290 Moscow TASS in English 1055 GMT 6 Apr 90

[Text] Moscow April 6 TASS—By TASS special correspondent from the Mission Control Center:

Over the past week Soviet cosmonauts Anatoliy Solovyev and Aleksandr Balandin together with specialists from the Mission Control Center tested various motion control regimes and prepared scientific equipment for forthcoming experiments.

They also continued studies of the influence of outer space on various materials with the help of equipment on the outer surface of the reequipment module.

Today they will conduct experiments to evaluate structural material and elements of the radio-electronic equipment.

Last week the crew carried out many medical tests, including with the use of ultrasonic equipment. According to the results, both cosmonauts are in good health.

Solovyev and Balandin continue to fulfil the flight program.

Crew Completing Second Month Aboard Mir

LD1004105690 Moscow TASS in English 1039 GMT 10 Apr 90

[Text] Moscow April 10 TASS—By TASS correspondent:

The second month of the orbital flight of Soviet cosmonauts Anatoliy Solovyov and Aleksandr Balandin on the orbital complex Mir is drawing to an end.

Today's agenda includes scientific, engineering and medical research and routine maintenance of some on-board systems of the basic module.

Using a portable spectrometer, the cosmonauts will take several series of measurements of spatial and energy characteristics of X-ray and gamma-ray radiation in the compartments of the orbital complex.

The experiment "Monitoring" will be performed to judge the strength of the structural elements of the Kvant-2 module with the use of accoustic sensors installed inside it.

The cosmonauts continue to perform experiments to measure the fluxes of micrometeorites in near-earth space and to study the influence of open space conditions on various materials.

Scientific information is being conveyed to earth, where it is processed.

The two cosmonauts are in good health.

Cosmonauts Activate New Computer, Electronics Interfaces

LD1704180390 Moscow TASS in English 1712 GMT 17 Apr 90

[By TASS correspondent]

[Text] Moscow April 17 TASS—Anatoliy Solovyev and Aleksandr Balandin continue their space mission.

The cosmonauts have fulfilled many difficult operations to install additional equipment aboard the Mir complex. They put into operation a new computer and several electronic interface systems.

They switched in power gyroscopic stabilisers of the Kvant-2 module into the general circuit of the Mir complex on Sunday [15 April].

In compliance with the plan of preparing scientific equipment for forthcoming experiments, the crew assembled an additional TV unit [in] the re-equipment module.

The unit will monitor geophysical investigations with the videospectral instrumentation of the Kvant-2 module.

Work in the complex proceeds according to schedule.

The cosmonauts are healthy and feel well.

Commentary on Kvant-2 Docking Problem

907Q0033 Moscow TRUD in Russian 28 Nov 89 p 4

[Article by TRUD special correspondent V. Golovachev: "Will the Docking Succeed?: Commentary on an Unusual Situation That Occurred in Orbit"]

[Text] As designers conceived it, the multipurpose complex being assembled in near space, in near-earth orbit, will consist of several units or, more precisely, modules. The base unit, Mir, is a sort of space house where the crew members engage in sports, sleep, have breakfast, dinner and supper, and rest. But research, work with semi-industrial installations, and experiments are to be carried out mainly in large specialized modules that are inserted into orbit separately and dock with the orbital complex. These mini-institutes or mini-plants are comparable in size and mass (they weight up to 20 tons) to the base unit, and in the future they could make up a complex, 100-ton structure in orbit.

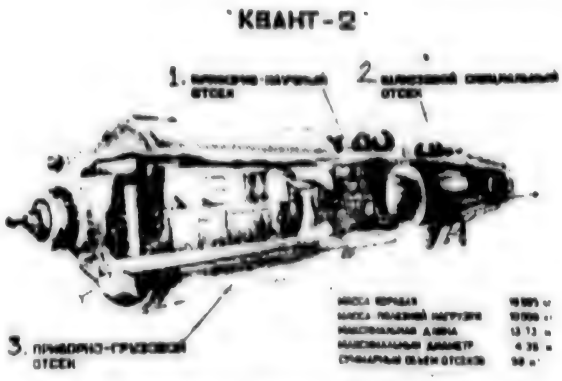
The first such module, Kvant, has already been operational for more than two years as part of the space complex. But the wait for the second module, Kvant-2, has been a long one. At first they did not want to send it into space until the third module was ready (since they were to form a symmetrical system, which makes it easier to control the complex). Incidentally, it is for that reason that the regularly scheduled expedition aboard Mir was postponed this past spring, since the efficacy of a space watch would diminish appreciably at this stage without Kvant-2. Then the Kurs docking system came under suspicion. In this module, in addition to new equipment, there is also a "space motorcycle," a device to enable cosmonauts to move about on their own in open space, which opens up new possibilities for working in orbit.

Then there was the long-awaited launch of Kvant-2 on Sunday, 26 November. However, this "unlucky" module demonstrated its obstinacy in space, too. After the module was place into orbit, one of two arrays of solar batteries did not open up completely. That immediately created problems for execution of the program that had been outlined. In the first place, it became difficult to turn or control the module. Just imagine a 20-ton structure on one side of which an array many meters long, with an area of tens of square meters, opens, but on the other side the array does not open completely. The center of mass changes, and you have a difficult situation.

In the second place (and perhaps it is also in the first place), the possibilities for supplying power to the module are diminished considerably. Remember that power is as essential to a space vehicle as air is to earthlings. Without power, the module can't exist or be controlled.

There are two top-priority questions at the present time: why was there a malfunction, and will Kvant-2 dock with the orbital complex? There is no clear-cut answer to either question as yet. The telemetry data are being examined, and various situations are being "played out" with computers, on ground-based analogs of the module. Incidentally, as reported to me by one of the specialists, repeated prelaunch checks at Baykonur failed to reveal any problems—the array opened beautifully, exactly as it was supposed to.

What might the prognoses be in this case? Specialists believe that it possible to control the attitude of the module even if one array is not open. As for power, they have found a solution there, too. They have disconnected all secondary instruments and sources using electricity. And, finally, the possibility of making an attempt to open the unfortunate array is under study. There are various ways, including "shaking" the module (by turning the engines on). If there is something jammed in the rather complicated mechanism for opening the array, perhaps shaking it would eliminate the problem.



The Kvant-2 module (TASS photo)

Key: 1. Equipment/scientific section—2. Special air lock—3. Service/cargo section—4. Vehicle mass: 19,565 kg—5. Payload mass: 10,000 kg—6. Maximum length: 13.73 m—7. Maximum diameter: 4.35 m—8. Total volume of sections: 59 m^3

Be that as it may, everything possible will be undertaken to save the module, which costs many millions. I believe that Kvant-2 will be docked with the Mir/Kvant/Soyuz TM-8 complex.

There had also been malfunctions involving the opening of solar batteries of prior versions. This is the first such malfunction on this model. Incidentally, the array was assembled at the Khrunichev Moscow Plant.

The state commission is working on the problem. After assessing the situation, it will decide exactly how to get out of this predicament.

Launch of 'Kristall' Module Postponed Until June

LD2004123190 Moscow World Service in Russian 0930 GMT 20 Apr 90

[From the "Soviet Chronicle" feature of the "Soviet Union Day by Day" program]

[Text] The launching of the Kristall technological module to the Mir orbital complex scheduled for April has been postponed once again, this time until the beginning of June. This was reported by Yuriy Semenov, the chief designer of rocket and space systems.

The 20-ton orbital minifactory is intended to reproduce various semiconductors and biomaterials in weightlessness. Right now it is at the Baykonur cosmodrome. Specialists want to be completely sure that the module is reliable so that it can dock safely with Mir.

Semenov Comments on Launch Postponement

LD2004201690 Moscow Domestic Service in Russian 0330 GMT 20 Apr 90

[From the "Utro" news feature; presented by Aleksandr Tikhonov]

[Text] [Tikhonov] In the past two months our program has been constantly reporting that in April a new, third module would be sent up to the Mir orbiting complex on which cosmonauts Anatoliy Solovyev and Aleksandr Balandin are working. This is a specialized workshop for producing especially valuable materials in space. The crew's main work aboard the complex was connected with it. And so it has become known that the launch of the module has been postponed until the beginning of June. Our correspondent Leonid Lazarevich asked Yuriy Pavlovich Semenov, the general designer of the Energiya scientific production association, and his deputy, Valeriy Viktorovich Ryumin, to comment on the situation which has arisen.

[Begin recording] [Semenov] Indeed, after the Kvant-2 module had been docked to Mir, 12 gyrodynes were deployed for the first time in world practice on board such a complicated system. This is a most complicated mechanical unit. When we used 12 gyrodynes, we switched on some of the equipment that had not been used during four years of flight. We needed time to analyze the situation that had arisen. What I must say today is that what I must frankly call breakdowns have been specifically detected.

Literally yesterday, we succeeded in obtaining all parameters—11-12 gyrodynes. I must say that 11 gyrodynes are capable of effecting the orientation of such a complicated cluster, whose control is designed for four modules—not for two modules, which we have today, but four. We have been fighting to have the certainty at last that there would be four modules. We have received such certainty.

Well, we have somewhat revised our program; and prior to the Kristall module, in the first 10 days of May, a Progress craft will be delivered that will supply the fuel already needed for subsequent work. It must be said that this is very difficult and complicated, and that one runs into all kinds of unforeseen circumstances. And we have to model this on earth. We will have to deliver some parts to the station. This is our usual procedure, and this does not frighten us.

[Ryumin] This is not unusual. Any equipment is entitled to break down. And during many years of working with stations we have accumulated sufficient experience to get out of such situations safely. For this reason, this has not been anything unexpected for us. We are capable of maintaining the normal functioning of the station. [end recording]

[Tikhonov] Evidently, that is the case. There will be no lack of work for the cosmonauts aboard the complex. But prior to the launch it was said that the current expedition should become the first to make a profit, and these hopes were above all pinned on the module. Meanwhile, its launch is being postponed already for the umpteenth time.

Computer Incompatibility Blamed for Module Launch Delay

PM2404120590 Moscow IZVESTIYA in Russian 21 Apr 90 Morning Edition p 6

[Report by S. Leskov: "Latest Launch Delay"]

[Text] The launch of the "Kristall" technological module, considered one of the main "space" events of the year, has once again been postponed.

It is hard to calculate how many times the launch of the technological module, on which for the first time in the history of space exploration the industrial production of various materials with fundamentally unattainable properties under earth conditions is to begin, has been postponed. As a result cosmonauts Viktorenko and Serebrov, who have been specially trained to conduct technological work and who even "held back" their launch for several months, were simply unable to wait for the module in orbit. The last in the series of launch dates was 18 April. However, the "Kristall" module, which has already been at Baykonur for a long time, did not head off into space on that day either.

The next launch date is 1 June. Yet Solovyev and Balandin, who are currently working in orbit, are to complete their flight in July...

What held up the launch this time? V. Blagov, deputy flight chief, told IZVESTIYA's correspondent that the launch postponement is not directly associated with the technological module's readiness—"Kristall" is perfectly in order. But the powerful "Salyut-5B" on-board computer is currently being tuned up on board the "Mir" orbital complex, where new spaceships are constantly docking. It is already difficult for the former "Argon 16B" computer to control the complex with the complicated spatial configuration and with the significantly increased quantity of apparatus. Thus, five mainframes with a total capacity of over 2 million operations per second are currently operating on board the "Mir" complex. This is quite commensurate with the large ground-based computer complexes installed, for instance, at the flight control center itself.

However, according to V. Blagov, it proved considerably more difficult than first imagined to organize intermachine compatibility. All this is not so much a fault as a problem of space exploration. The problem of intermachine compatibility is successfully resolved in many countries, but it is hard to expect a breakthrough in this field with our electronics.

The first-stage tests confirming that the computer is successfully performing all the basic operations were only completed 19 April. However, we will have to wait a while before further checks since "Mir" is to receive the "Progress" tanker in early May, and it is only compatible with the old computer.

Hopefully it will prove possible to avoid further delays with the "Kristall" module launch. But even then the lag behind schedule will inevitably result in a reduction of

approximately 20 percent in the technological, medical, and biophysical studies conducted using apparatus carried by the module within this expedition. If we take into consideration the fact that, according to general designer Yu. Semenov's figures, the expedition's economic efficiency was estimated at R105 million, then the losses from the latest postponement alone may be estimated at R20 million.

Delayed launches of modules destined for the orbital complex, which was also conceived as a conglomerate of many space facilities, have become regular occurrences. At this rate, it is not known when another two modules, in addition to "Kristall," will reach "Mir." After all, the orbital complex, which was put into orbit four years ago, is steadily coming to the end of its resources.

'Granat' Observatory Starts Operation

LD2912085489 Moscow TASS in English 0842 GMT 29 Dec 89

[Text] Mission Control Center December 29 TASS—The international orbiting observatory Granat has successfully completed its check up of on-board systems. Specialists continue regular communication sessions with the space craft to control its exact orbit.

In December experts from the Soviet Space Research Institute, Denmark, Bulgaria and the French nuclear and space centers tested on-board scientific equipment.

The joint analysis of the data showed that the equipment to study space gamma and roentgen radiation is functioning normally.

The experts also registered high solar activity and a great number of powerful and weak roentgen flashes. Granat has also monitored the first space gamma [bursts].

In January three major telescopes of the observatory will begin round-the-clock monitoring of active galaxies' nuclei and the giant accumulation of galaxies in the Perseus constellation and supernova components in the Large Magellanic Cloud.

Granat Observatory Satellite Continues Research Program

LD2903162490 Moscow TASS in English 1102 GMT 29 Mar 90

[Text] Moscow March 29 TASS—An international space observatory, Granat, put into orbit around the earth on December 2, 1989, continues to carry out the planned program of research of stars, galaxies, the sun and space sources of X-ray and gamma-ray bursts.

Thirty-two sessions of observation each 20 to 46 hours long were conducted in February and March 1990 from on board the space apparatus. X-ray images of a gigantic cluster of galaxies in the Perseus Constellation have been received and the temperature of intergalaxy gas there has been measured.

The mapping of our galaxy's center has been carried out. Periods of rotation of neutron stars—X-ray pulsars in Hercules, Cassiopeia, Perseus and Centaurus have been measured.

On the night of March 18, when the Granat observatory was 150,000 kilometers away from the earth, all its instruments registered a unique power burst from the sun which lasted for several hours.

Once in several days, the observatory's instruments register gamma-bursts. The information received from on board the satellite is processed and analyzed at the Soviet Academy of Sciences' Space Research Institute and laboratories in France, Denmark, and Bulgaria.

Technical experiments were carried out during the flight which expanded the number of examined objects. In April, it is planned to continue the research on our galaxy's center, X-ray pulsars and active galaxies' nuclei.

Notes on Plesetsk Cosmodrome

907Q0031 Moscow VOZDUSHNYY TRANSPORT in Russian 14 Oct 89 p 3

[Article by VOZDUSHNYY TRANSPORT special correspondent S. Omelchenko: "Peaceful Launches from a Military Range: A Report by Our Special Correspondent, S. Omelchenko, from the Plesetsk Cosmodrome"]

[Text] It was possible to touch the rocket. Its smooth, perfect body was doomed in several hours, after separating in stages from the payload, to cease to exist as a single and useful whole. It was all the same to the rocket, whether it carried a lethal projectile to an intended target or inserted a space vehicle into a near-earth orbit. It was for the people to decide which was more important. The people had confidence in the rocket. During the last few prelaunch hours, they were more occupied with the satellite.

You could not touch the satellite. It was not yet hidden under the fairing, but it was covered almost to the top by solar panels. Behind their shields was a most complicated filling. There, in space, the automatic general-purpose orbital station will look somewhat different. The batteries' petals will unfold, a unique antenna will be deployed into a ring with a diameter of 20 meters, and a tiny, almost toy-sized subsatellite will separate...

This spacecraft is intended for basic research in the fields of geophysics and heliophysics, in which specialists from the USSR, the GDR, Bulgaria, Czecholovakia, Poland, Hungary, Romania, Mongolia, Cuba, and France are participating. The scientists hope that the obtained results will make it possible to expand their notions about near-earth space, the characteristics of galactic and solar rays, the properties of the earth's ionosphere, and the bioproductivity of the World Ocean.

Nearly everyone who gives an explanation of how the equipment should behave after the launch looks around in search of a piece of wood—to knock on for luck. People will always be people, before a bicycle race or before the launch of a space rocket. In their superstitions, in their hopes for success, in their doubts and in their desires to live better than they are now.

We know so little about how much space is costing us, what it is producing and what it may produce—after all, that information has been kept strictly secret. But, obviously, it has become impossible to put up with this ignorance any longer, for there have indeed been examples in history in which people have turned their anger against scientific and technical progress, without, however, gaining anything from doing so.

And now the cosmodromes opened their own doors to journalists. To Plesetsk came representatives of the press from Poland, Bulgaria, the American news agency UPI, USSR Gosteleradio [State Television and Radio], and the Vremya program and journalists from the central, oblast and city newspapers, including those aspiring to a flight into space, who had successfully gone through the first, creative round of tests and had presented well-reasoned explanations of their desire to make a trip into space.

It was probably the first time the cosmodrome had ever received so many journalists at one time, and at such a crucial and tense moment, when two launches were being prepared back to back: a launch at 1738 hours of a Molniya-1 satellite, intended to relay television programs and to provide duplex multichannel telephone communication between Moscow and the cities of Siberia and the Far East, and a launch at 0305 hours of an unmanned general-purpose orbital station, the inspection of which our trip around the cosmodrome began with.

But the cosmodrome consists of more than just the assembly-and-testing complexes and the launch pads. It is a city, where there is a military garrison, with the symbolic title of Mirnyy [Peaceful]. The military built the cosmodrome, but now, several years later, it specializes in launching spacecraft. Plain but warm multi-apartment buildings, a bakery, a confectioner's shop and a store for non-alcoholic drinks, farms and greenhouses—the head of the cosmodrome, I. Oleynik, is as proud of all this as he is of the space achievements. And yet, I still have to admit that it was complete surprise for me to hear from him, a lieutenant general, the most detailed information about how to store vegetables and the small discovery made by him personally of how, there in the north and without any extra expenditures, to provide the populace spring onions all year round. However, this is not his only achievement by far.

What gives the city a special coziness are the birch trees planted along the streets, but what is really unique are the monuments. In what city, would you say, and on what street, furthermore, is it possible to see a genuine, solar-wind-scorched craft that has been in space and returned to Earth?

Of course, not every satellite is so honored. But this one, the Kosmos-2000, is special. There were almost no reports of it in the press, and the populace's dissatisfaction with the expenditures for space programs was so pointed that there was almost no mention in the mass media about the new space achievement. The number 2000 appealed to someone. But the celebration of its anniversary here is quite accidental. The spacecraft, which was launched from the cosmodrome near the city of Mirnyy on 10 February of this year at 1955 hours, was the first such craft in the entire history of the space program to photograph Antarctica's polar cap. And that occurred 170 years after the Russian sloop *Mirnyy* became the first ship to touch the shores of that ice-covered continent.

The other side of the moon, as we will recall, was photographed from space a long time ago, but, until now, no one had managed to get photographs of Antarctica. Is it necessary to remind you of why we are interested in this land mass? As much as 80 percent of the pure fresh water reserves are found there, and up to 18 percent of the oil reserves and gas are in the shelf. Finally, the weather kitchen is located there.

Today, the Plesetsk Cosmodrome and the city which services it, Mirnyy, specialize in launches of unmanned spacecraft. For us, the reports of a routine launch of a satellite have become just ordinary information. But for those who work here, each launch is just like the first. The responsibility is too great, each mission into space too costly, and the hopes too large that scientists—as well now as many economists—pin on each mission for anyone to make a mistake.

From here, not so long ago, the Bion spacecraft, with monkeys and other animals on board, was launched. During that flight, research was conducted on vestibular and motor mechanisms, the cardiovascular and nervous system of the animals' bodies, and the effect of space radiation on biological subjects. Experiments were performed on protecting living organisms from the harmful effect of the earth's radiation belts. The data obtained will help advance practical medicine.

Dozens of beneficial things can be credited to the Okean satellite. With the satellite's help, it was possible to lead the vessel Mikhail Somov out of icy captivity, to detect flooded areas when the water was high on the Amur River in 1984, to pilot ships in the Long Strait in 1983 under extreme icy conditions and in the Sea of Okhotsk and the Tatar Strait in 1985, and to obtain radar maps of the Arctic and the Antarctic. Reconnaissance of the ice conditions and bioproductivity of the ocean and the determination of temperature anomalies and the cloud cover—all these things have not exhausted the range of problems which can be solved by Okean. More than a dozen different departments are taking advantage of the information coming from it.

Specialists from many sectors of the national economy are interested in the work of the Resurs spacecraft, which is being used to identify natural resources and soil, plant, water and other resources and to monitor their use and the ecological impact of man's activities. Thanks to Resurs, it has been possible to fill in the blank spots on maps of the Pamir and Tyan-Shan mountain ranges and to add new details to maps of Chukotka, New Zealand, the Kuril Islands and the deserts of Central Asia. Information obtained from Resurs is being used by foreign consumers on a profit-taking commercial basis. The annual economic return from the launch of one such spacecraft amounts to 32-38 million rubles, which is considerably greater than the expenditures.

But what price can be put on the value of the human lives saved? The space-based COSPAS-SARSAT system makes it possible to substantially lower the outlays for searches for people in distress. People who suffer a catastrophe often die merely because help arrives too late. The space-based system receives a signal from an emergency radio buoy or beacon at any point on the earth and relays the signal to ground stations. The accuracy in determining the site of the tragedy is from 3 to 15 kilometers (when there are four satellites in the system). It is no big thing to equip aircraft and ships, fishing boats, expeditions and individual tourists with extremely simple radio beacons and radio buoys. Their cost is nowhere near the expenditures for the space-based system. Incidentally, the USA, France, Canada, Great Britain, Norway and Denmark are participating in this project, in addition to our country.

I do not know how it is in other countries, but in our country at least, there are no such radio buoys on airliners. There are the R-855UM radio stations, which make it possible to communicate on an emergency frequency. But there's one small detail: a radio buoy switches on automatically, while a radio station does not begin working without being switched on by a human being. But what if there is no one to turn it on? What if the radio operator has died or passed out? That, as we know from experience, makes the searches longer, and the result is often sad. Incidentally, there aren't even enough of these radio stations to go around for all the planes and helicopters. Such information has been received by the Ministry of Civil Aviation's Emergency and Rescue Operations Administration from Chief Engineer K. Subbotin. Konstantin Konstantinovich added that a version with radio buoys is being developed and that the device is undergoing tests. But, as it turns out, a contract for its delivery has not yet been concluded. Since 1982, the COSPAS-SARSAT system has been used in 205 instances and some 1,700 people have been saved. But were many of them our countrymen? Even the deputy chief of the cosmodrome, B. Morozov, could not give me an answer to that question. He could only emphasize that the space aspect of the problem has been completely solved, and that the Soviet Union is meeting all its own obligations and is bearing a large part of the costs. The rest is up to the rescue services on the ground.

The last few prelaunch minutes. The fueled rocket is undergoing the final preparations in automatic mode. And then, suspended in mid-air for an instant, it quickly disappears in the low cloud ceiling. The roar of its engines can even be heard in the city of Mirnyy, But it is a peaceful roar. And the rocket went into space for peaceful purposes, even though it was also launched from a military range.

UDC 521.1

Evolution of Orbital Elements of Artificial Earth Satellite Over Lengthy Periods of Time

907Q0007A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 27 Dec 87) pp 491-496

[Article by B. N. Noskov]

[Abstract] In an earlier work that was devoted to the problem of determining the life of a satellite during the final stage of its orbital motion in the Earth's atmosphere (KOSMICH. ISSLED., 1988, Vol 26, No 6), the author used differential equations for the intermediate-orbit Euler elements to derive an expression τ_l that represents the lifetime of a satellite. However, the actual life of a satellite differs from τ_l in that the life is based on the inital altitude of orbital perigee and on the transverse load factor. The higher the values, the greater the life of the satellite. For satellites whose orbits are even partially in the atmosphere, the nonangular elements and the altitude of perigee gradually diminish as a result of drag. When they reach their critical values, the satellite enters the denser layers of the atmosphere and is destroyed. Since that happens before the eccentricity of the orbit reaches zero, the true lifetime of the satellite is somewhat less than τ_l. The author presents an algorithm for calculating the actual life of a satellite; it is based on the relationship between eccentricity analogs and the major semiaxis of the intermediate orbit of an artificial satellite whose motion is affected by atmospheric resistance. References 4 (Russian).

UDC 531.36

Existence and Stability of Periodic Pendulum Motions of a Satellite

907Q0007B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 11 Jan 89) pp 497-501

[Article by N. I. Churkina]

[Abstract] The motion of a satellite relative to its center of mass is studied in the context of the theory of pendulum systems. In this case, the author describes the satellite motion in terms of a model of the motion of a mathematical pendulum affected by a general, periodic perturbation ε. The conditions for the existence and stability of periodic Poincare solutions are derived in a strictly nonlinear formulation. References 9 (Russian).

UDC 629.197.2

Two-Pulse Transfers

907Q0007C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 17 Nov 87) pp 509-513

[Article by A. I. Averbukh]

[Abstract] Plane transfers between two coplanar Keplerian orbits—one arbitrary elliptical, the other circular—are examined. The motion along both orbits is in the same direction. Transfer from point *A* of orbit I to transfer orbit P (coplanar with both orbits) and from orbit P to point *B* of orbit II is done with pulses ω_1 and ω_2. The set of points on the plane (ω_1, ω_2) derived for all possible points *A*, *B* and all possible orbits P make up the so-called ω-region of orbits I and II. The author seeks algorithms for finding ω-region boundary points and the transfer orbits that correspond to those points. Characteristics of special boundary points are calculated. Figures 2, references 4 (Russian).

UDC 550.385.41

Combined Ground and Satellite Measurements of Narrow Ionization Troughs in the *F* Region

907Q0007D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 14 Mar 88) pp 568-584

[Article by V. M. Filippov, D. D. Reshetnikov, V. L. Khalipov, V. S. Solovyev, A. Ye. Stepanov, Yu. I. Galperin, and T. M. Mulyarchik]

[Abstract] After the polarization jet was discovered and described some years ago, researchers found that, at subauroral latitudes in the ionosphere, either the narrow stream of rapid drift to the west was accompanied by the formation of a narrow, deep trough of ionization in the existing background electron concentration in the *F* region, or the main trough was deepened along the polar wall, creating a "trough within a trough." Although the morphological characteristics of narrow ionization troughs—e.g., spatial dimensions, relation in time to substorms, and seasonal-cyclic variation—are properly studied with regular, ground-based ionospheric measurements, difficulties arise in connection with the considerable distances between stations, the complexity associated with interpreting the data of "anomalous" ionograms whose reflected signal is scattered, and the location of the phenomenon on certain invariant latitudes with too few stations. The authors examine a number of instances in which measurements of substorm effects in the subauroral ionosphere were made simultaneously from aboard satellites at different altitudes over the Yakutsk region and ground stations in the Yakutsk region. The first set of data they examine was derived in the ARCAD-3 project on 25 February 1982, when Oreol-3 measurements were used to construct a latitude profile of the intensity of incoming particles in the region of the trough of the upper *F* region (approx. 550-580 km). Ground-based measurements recorded the position of the polar edge of the main ionospheric trough and the location of the narrow ionization trough in the lower *F* region. Simultaneous measurements involving DE-1 and DE-2 satellites looking at the plasmasphere and the upper *F* region were also analyzed. The data pertained to 7 October, 8 October, 12 November, and 20 November 1981. The authors conclude that narrow ionization troughs form in the nighttime subauroral ionosphere as a result of the rapid transfer of ionospheric and magnetospheric thermal plasma in the band of rapid, westward drift and especially in the lower *F* region and as a result of variations in the rates of photochemical reactions. The polarization jet typically lasts 2-3 hours, after which the narrow trough merges with the main trough. The appearance of a band of rapid drift in the subauroral region can be an important mechanism of formation of the main ionization trough in the near-midnight and after-midnight sectors. The authors did not find any precipitation of lower-energy particles in narrow troughs, which showed good correspondence with the ionosospheric *L* layer. A narrow trough of electron concentration was found within the plasmopause. The polarization jet generally oppears near the initial phase of growth of the positive coil in the *H* component and of the growth of the *AE* index of the geomagnetic field. The latitude difference between the position of the polar wall of the main trough and the narrow trough was 10° at times and was greatest when a substorm was developing and smallest at the end of the phase of substorm recovery. Figures 7, references 39: 16 Russian, 23 Western.

UDC 550.383

Investigation of Plasma Mantle of Earth's Magnetosphere. 4. Standing Plasma Structures

907Q0007E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 24 Aug 87) pp 585-594

[Article by E. M. Dubinin, A. V. Zakharov, N. F. Pisarenko, R. Lundin, B. Khultkvist]

[Abstract] Recent studies have suggested the possibility that with a northward IMF, there is a total restructuring not only of magnetospheric plasma flow, but also of the entire configuration of the magnetosphere. The researchers here study the high-latitude plasma mantle/boundary layer features that are associated with the possible formation of polar-cap closed force lines. Such features are found in periods of northward IMF, when fields of "hot, standing plasma" appear with characteristics similar to those of the plasma in the plasma sheet. The data presented is based on measurements made by the Prognoz-7 satellite, which was placed in a high-apogee orbit 31 October 1978. The satellite carried the Promiks-1 instrument, which was designed to measure the energy spectra of electrons and ions and to analyze mass and energy of positive ions in various ranges. The

authors conclude that the clouds of standing plasma in question are closer in their parameters to the plasma sheet than to the transition region, which indicates that the force lines that thread the plasma are closed and take part in sunward convection. It is suggested that the closed force lines convecting in the magnetospheric tail and forming after recoupling in the cusp region reconnect in the plasma sheet. As a result, the magnetospheric tail is bifurcated. The clouds of plasma maybe also be simply inhomogeneities of the plasma sheet. Figures 7, references 26: 6 Russian, 20 Western.

UDC 523.037:525.7

Recording of Rise in Fluxes of High-Energy Particles in Region of Brazil Geomagnetic Anomaly on 10 September 1985

907Q0007F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 4 May 88) pp 629-631

[Article by S. A. Voronov, A. M. Galper, V. G. Kirillov-Ugryumov, S. V. Koldashov, V. V. Mikhaylov, A. V. Popov, and V. Yu. Chesnokov]

[Abstract] Satellite studies of recent years have included a number of experiments involving investigation of fluxes of high-energy electrons and positrons. The experiments culminated in the discovery of a belt that consists mainly of electrons with energies in the dozens of mega-electron volts and with a maximum intensity at L of approximately 1.5. This paper describes the sharp increase in intensity of high-energy particles recorded on 10 September 1985 from aboard the Salyut-7 station as it passed through the Brazil geomagnetic anomaly, where the radiation belt drops to the orbital altitude of the station and an increase in intensity should be primarily due to the particles in the belt. The particle flux was recorded with a Mariya scintillation transit-time magnetic spectrometer during routine observing sessions; the particle count rate rose sharply on three of four passes through the anomaly. In the 20-40 MeV/s range, the recorded flux consisted almost entirely of negatively charged particles and was several times greater than the fluxes recorded on other days. The count rate was dozens of times higher than usual at 60 MeV/s or greater, with charge composition shifting to the positive side. The absence of noticeable global disturbances of the geomagnetic field suggest that rises in particle flux may have been due to local disturbances of the Earth's magnetosphere. The researchers propose the possibility of a link between rises in particle flux and earthquakes, noting that electromagnetic waves, which could be precursors of earthquakes, are observed several hundred kilometers above earthquake foci and could be the cause of the precipitation of particles from the radiation belt. They point out that 38 earthquakes with a magnitude of 4 or greater occurred on 10 September 1985, whereas the number of earthquakes on the other days of the observation period (1 August through 30 November 1985) rarely exceeded 20. In addition, 14 of the 38 earthquakes occurred in the New Britain area, which is on virtually the same meridional plane as the Brazil geomagnetic anomaly. References 5 (Russian).

UDC 551.521

Fine Structure of the Ion Distribution Function Behind the Near-Earth Bow Shock Front

907Q0007 Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 10 May 1988) pp 631-636

[Article by O. L. Vaysberg, Ye. I. Kolesnikova, G. N. Zastenker, V. N. Smirnov, Z. Nemechek, Ya. Shafrankova, I. Kozak]

[Abstract] The mechanisms of the thermalization of plasma at the bow shock front in a collisionless plasma are not fully understood. Attempts to explain the multipeak structure found in the ion distribution function as fluctuations of hydrodynamic parameters meet with considerable difficulty. In earlier papers (KOSMICH. ISSLED., 1986, Vol 24, No 2, p 166; ADV. SPACE RES., 1986, Vol 6, No 1, p 41; KOSMICH. ISSLED., 1986, Vol 24, No 2, p 151), Vaysberg *et al.* suggested that the observed effect reflects the actual structure of the flux of ions just behind the front, one possible source of the phenomenon being the nonstationary nature of the bow shock front. In this paper, they set out additional proof of the nonstationary passage of the flux of solar wind ions through the front of a strong, quasiperpendicular bow shock they described in earlier work (M_{MS} = 4.7; θ_{BN} = 86°). They determine the "temperatures" of ion beams recorded behind the front on individual energy steps across the entire energy range observed for the 30.72-second interval between 15:55.31.4 UT and 15:56.02.12 UT. The distribution peak was found to lie between 3.0 and 4.0 eV, and the average beam temperature was about 7 eV. That indicates that a simple mechanism underlies the passage of ions through the bow shock front: as a result of a discontinuity in the electrostatic field, the ion beam stretches in the velocity space in a direction perpendicular to the front. Gyration in the magnetic field behind the front leads to a change in the direction of anisotropy of the beam in the phase space in a plane perpendicular to the magnetic field vector. The velocity spread of the beams is evidently linked to fluctuations in electrostatic potential at the front. The researchers suggest that evidence of the multibeam nature of the ion distribution function consists in the ring structures that are found in the dynamic spectra. Figures 3, references 18: 6 Russian, 12 Western.

UDC 551.593

Interpretation of One Feature in the Distribution of the Night Airglow of the Ionosphere

907Q0007H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 16 May 88) pp 636-638

[Article by G. M. Grechko, V. I. Petviashvili, N. V. Petviashvili, and A. Ya. Feldshteyn]

[Abstract] Cosmonauts aboard the Salyut-6 station made visual observations of the night airglow at various altitudes, including those of the first emission layer. Because the human eye is most sensitive to the green region of the spectrum, which includes emissions at the wavelength of 557.7 nm, the visual observations are considered reliable. The cosmonauts repeatedly observed altitude stratification of the first emission layer, a phenomenon the researchers here felt was inadequately described in the literature. That prompted them to demonstrate that the stratification of the airglow at altitudes of the lower thermosphere can be attributed to the presence of disturbances in the neutral composition of the atmosphere that are caused by three-dimensional solitons of Rossby waves. References 13: 7 Russian, 6 Western.

UDC 523.64

Investigation of Gas and Dust Production in Halley's Comet Based on Ground-Based Spectrophotometry

907Q0005A Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 5 No 4, Jul-Aug 89 (manuscript received 4 May 88; after revision 08 Sep 88) pp 38-44

[Article by D. I. Shestopalov and A. A. Atai, Shemakha Astrophysical Observatory, AzSSR Academy of Sciences]

[Abstract] Astronomers at the AzSSR Academy of Sciences Shemakhin Astrophysical Observatory used spectrophotometric observations to determine the rate of formation of parent molecules CN, C_3, and C_2, as well as dust production, in Halley's Comet. The astronomers tracked the comet for a period of 10 days beginning in December 1985 and ending in January 1986, through perihelion. The observations were performed on a 70-cm AZT-8 telescope, whose Cassegrain focus (F = 11 m) included a photoelectric scanning spectrometer. The resolution of most spectra was 2.48 nm in the range of 380-740 nm. On December 9 and January 1, the comet's spectra were from the range of 380-470 nm, with a resolution of 0.98 nm. Observation time did not exceed one hour a night. The variation in gas- and dust-production quantities as the comet approached the Sun was examined, and rate of formation of the parent molecules was compared with the rates associated with 17 other comets, some periodic and other nonperiodic. Because the isotropic flow ratios $Q(C_2)/Q(CN)$ and $Q(C_3)/Q(CN)$ for all the comets did not correlate with the heliocentric distance, the reasearchers concluded that the rate of formation of the parent molecules—for Halley's Comet as well as the others—is determined primarily from the physical properties of the nucleus, which means that the thermophysical and mechanical properties of the nucleus, plus the level of volatile components in the nucleus, serve as the "trigger mechanism" for a comet's activity. The researchers also compared their findings with the phase dependence of the brightness coefficient of the coma-nucleus system, as determined from observations made from aboard the Vega spacecraft. A figure demonstrates that the ground-based photometric functions of the dust of Halley's Comet are within 10% of the space-based functions. Figures 3, references 16: 4 Russian, 12 Western.

UDC 523.98

Areas of Lengthy Activity on the Descending Branch of Solar Cycle 21

907Q0005B Kiev KINEMATIKA I FIZIKA NEBESNYKH TEL in Russian Vol 5 No 4, Jul-Aug 89 (manuscript received 1 July 88; after revision 22 Aug 88) pp 62-68

[Article by V. G. Banin and S. A. Yazev, Siberian Institute of Terrestrial Magnetism, Ionosphere, and Radiowave Propagation, Siberian Department, USSR Academy of Sciences, Irkutsk]

[Abstract] The Soviet researchers examine the characteristics of the space-time distribution of areas of lengthy activity on the descending branch of solar activity of solar cycle No. 21, and they link such areas with flare activity. They use the characteristics to describe sunspot activity in an attempt to develop a new index of activity that isolates the photospheric activity component that is most closely related to large proton flares. The researchers present a technique for identifying the areas of lengthy activity and a procedure for assessing the indexes, and they compare such indexes to the Wolf numbers and frequencies of a class of proton events. The areas of lengthy activity are found to be high intermittent on the descending branch of cycle No. 21, which points to global changes in the solar magnetic fields with a period of roughly 20 solar rotations. Figures 3, references 15: 7 Russian, 5 Czech, 3 Western.

UDC 524.35

The Star That Exploded as Supernova 1987 A

907Q0004 Yerevan ASTROFIZIKA in Russian Vol 30 No 2, Apr 89 (manuscript received 10 Apr 89) pp 449-450

[Article by G. M. Tovmasyan, R. A. Yepremyan, R. Kh. Oganesyan, Yu. M. Khodzhayants, M. N. Krmoyan, A. L. Kashin, D. Yugenen, V. V. Butov, S. I. Serova, Yu. V. Romanenko, A. P. Aleksandrov, Byurakan Astrophysical Observatory, ArSSR Academy of Sciences; Geneva Observatory, Switzerland]

[Abstract] The researchers show that the brightness of Sk-69°202, which is believed to have been the star that exploded as supernova 1987A, has considerably diminished in the UV range, at the wavelength of 1640 A. The star is not visible on photographs taken on 27 August 1988 with the Glazar space telescope on the Kvant module, aboard the Mir station. Two photographs were made with 3-minute exposures, and four were made with 1-minute exposures, the 1-minute exposures showing good quality. The absence of the star on the photographs indicates that Sk-69°202 is no longer a B3 type star and is the star that exploded. Figures 1, references 6: 2 Russian, 4 Western.

UDC 524.354

Observations of X-ray Pulsars With Rentgen Observatory Instruments on the Kvant Module

907Q0001 Moscow PISMA V ASTRONOMICHESKIY ZHURNAL in Russian Vol 15 No 8, Aug 89 (manuscript received 21 Feb 89) pp 675-685

[Article by M. Gilfanov, R. Sunyayev, Ye. Churazov, V. Loznikov, V. Yefremov, A. Kaniovskiy, A. Kuznetsov, N. Yamburenko, A. Melioranskiy, G. K. Skinner, O. Al-Emam, T. G. Patterson, A. P. Willmore, A. S. Brinkman, J. Heise, J. J. M. Int Zand, R. Jager, W. Voges, W. Pietsch, S. Doebereiner, J. Englhauser, J. Truemper, S Reppin, H. Oegelman, E. Kendziorra, B. Mony, M Maisack, R. Staubert, A. N. Parmar, and A. Smith, Space Research Institute, USSR Academy of Sciences, Moscow; Laboratory of Space Research, Utrecht, Netherlands; Birmingham University, Great Britain; Institute of Exoatmospheric Physics of the Max Planck Society, Garching, FRG; Astronomy Institute, Tubingen University, Tubingen, FRG]

[Abstract] Results are presented from determinations of the periods of pulsation of a number of well-known pulsars—Her X-1, Cen X-3, SMC X-1, Vela X-1, and A0535+26. The measurements were made between 1987 and 1989 with instruments of the Rentgen observatory on the Kvant module, aboard the Mir space station. Values are given for the baricenter of the solar system and, when orbital parameters of a binary system are known, for the baricenter of the binary system. Energy ranges and time resolutions are given for the telescopes on the Kvant module: the shadow-masked TTM (energy range 2-30 keV, time resolution 1 sec); GSPS gas scintillation proportional counter (2-100 keV, 1.25-2.5 msec); Foswitch and Hexe detectors 20-200 keV, 0.3-25 msec); and Pulsar X-1 (50-1300 keV, 1-10 sec). Time analysis of the observation data was hindered by the short observations sessions (10-25 min), which were separated by 90 minutes, the orbital period of Mir. Three to six sessions a day were conducted. The 90-minute intervals led to false periods at frequencies of $\nu = \nu_0 +/- n/90$ min ($n = 1,2,...$), but the researchers used measures distinguished them from the true periods. Figures 9, references 19: 3 Russian, 16 Western.

UDC 551.510.53

Comparison of Experimental Data on Neutral Composition at Altitudes of Approximately 150-350 km With Upper Atmospheric Models

907Q0018A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 4 Aug 87) pp 691-698

[Article by K. I. Gringauz, A. V. Pavlov, N. M. Shyutte]

[Abstract] Existing semiempirical models of the composition of the upper atmosphere have a number of drawbacks: they do not account for the actual distributions of ionizing radiation intensity, dynamic processes, or photochemical processes or the error in correlation dependences of n_i on model input parameters. In addition, most of the n_i data in the models has been collected by satellite, which virtually precludes separating vertical and horizontal variations in n_i. That prompted the researchers here to compare concentrations of O, O_2, and N_2 measured by geophysical rockets launched over a 15-year period (1965-1980) by the USSR Academy of Sciences with values for n_i computed with the Bates-Walker formula for diffusive equilibrium approximation in three commonly used models—the MSIS, DTM, and C models. UV absorption characteristics at wavelengths of various spectral ranges were used for obtaining data on the concentration, composition, and temperature of the neutral particles of the upper atmosphere. Although the rockets were launched only once every 1-2 years, experiment parameters were consistent enough to enable the researchers to make definite conclusions about the dynamics of the neutral component and the possible sources of the variations. The experiments were performed in quiet geomagnetic periods, with $F_{10.7}$ of 73-159. The comparison indicates that the models in use today provide a fairly good description of the status of the neutral component during quiet conditions with low solar activity and are more than approximate for increasing and high solar activity, in spite of significant differences in basic neutral component concentrations n_n and neutral atmosphere density ρ. Figures 4; References 17: 4 Russian, 13 Western.

UDC 543.42:522.124

Characteristics of CNO Group Ion Fluxes at Approximately 400 km Altitude in 1984-1986

907Q0018B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 26 Feb 88) pp 703-708

[Article by N. L. Grigorov, V. V. Bobrovskaya, P. V. Vakulov, D. A. Zhuravlev, M. A. Kondratyeva, L. P. Papina, A. V. Podgurskaya, M. G. Tarko, Ch. A. Tretyakova, and S. P. Tretyakova]

[Abstract] Beginning in 1984, the authors regularly observed nuclei with charges Z of 6 or greater and energies of 5-20 MeV/nucleon in near-earth space with dielectric track detectors aboard Cosmos series satellites with orbital inclinations of 70-73° at altitudes of 360-420 km. The detectors consisted of small stacks of 4-8 layers of cellulose nitrate (each layer 90-100 μm thick, with an area of 10-50 cm^2) with exposure times of 14 days. Particle energy was determined from the residual path range in the cellulose nitrate, particle charge from L R dependence curves. In 1984-1986, nearly 20 such exposures were performed. This article presents the experimental data relating to quiet periods. Comparison of the oxygen ion intensities recorded by the detectors and measurements made by IMP-8 in interplanetary space showed oxygen ion intensity measured by the researchers on the assumption that atomic oxygen is completely

ionized to be considerably greater than the intensity measured in interplanetary space. The intensity of single charged ions was also greater than than recorded in interplanetary space. That led the researchers to conclude that if the charge on oxygen ions is considerably greater than one, the excess oxygen recorded in the measurements is so great that additional fluxes of oxygen ions in the magnetosphere must be assumed. If oxygen ions are singly charged, a slight excess still exists, but the assumption of additional fluxes has less of a basis. They reason that accuracy in determining oxygen ion intensities in interplanetary space is not great and that their exposures (Nos. 10-14) did not cover the entire period from 20 April 1986 to 3 October 1986, for which measurement results were published for detectors aboard IMP-8. The possibility cannot be ruled out that during the periods in which the track detectors were not exposed, oxygen intensity in interplanetary space was lower than the level recorded in by the Cosmos detectors. Figures 3; references 16: 3 Russian, 13 Western.

UDC 550.385.41

Structure of Electric Field in Nighttime Subauroral Ionosphere

907Q0018C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 29 Feb 88) pp 709-716

[Article by I. Kutiyev, R. Koleva, Bulgarian Academy of Sciences]

[Abstract] The latitude profile of the subauroral convective field is studied in the premidnight sector under disturbed geomagnetic conditions, based on data obtained by the Dynamics Explorer-B and Intercosmos-Bulgaria-1300 satellites. The latitude profiles of drift are correlated to the instantaneous position of the so-called diffuse intrusion boundary. During storms, drifts with a large meridional component are observed, with rotation of the velocity vector to equatorial at the equatorial boundary of the polarization jet. During a large geomagnetic storm, an area with western drift toward the equator from the eastern polar vortex is observed in the evening sector. Two types of latitude profiles of subauroral convection are observed: the first a penetration of a large-scale convective field into subauroral latitudes; the second occurring when the large-scale convection field is shielded at the magnetospheric projection of the diffuse intrusion boundary, and a new electric field is generated in the magnetosphere located between the shielding layer and the Earth. Analysis shows that, during a geomagnetic storm, the large-scale convection field penetrates the diffuse intrusion boundary in the initial main phase, but then toward the equator from the boundary a new polarization field driving the subauroral ionosphere into a westward drift develops, the region occupied by the field intensifying and expanding toward the equator. Figures 3; References 16: 4 Russian, 1 Bulgarian, 11 Western.

UDC 523.72

Observation of Singly Ionized Helium in Solar Wind

907Q0018D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 21 Oct 88) pp 717-725

[Article by Yu. I. Yermolayev, V. I. Zhuravlev, G. N. Zastenker, V. T. Kogan, B. V. Koshevenko, A. K. Pavlov, Ye. V. Soboleva, and Yu. V. Chichagov]

[Abstract] It is generally acknowledged that the helium and hydrogen that make up solar wind are almost totally ionized because of high coronal temperature. Observations of He^+ in the solar wind, however, are quite infrequent, making any such observation important. The authors describe one case of observation of a flux of He^+ in an experiment conducted on the Prognoz-10/Intercosmos satellite during the Soviet-Czech Intershock experiment. The satellite was launched on 25 April 1985 into an elliptical orbit with an apogee of about 200,000 km and a perigee of about 500 km. The event occurred on 30 April 1985, when the satellite was deep in the magnetosphere on the ascending portion of the second revolution. The magnetosphere was severely compressed by a considerable increase in the dynamic pressure of the solar wind, which was moving with at a velocity of approximately V_p = 550 km/s, V_α = 520 km/s, a temperature of approximately $T_p = 1 \times 10^5$K, $T_\alpha = 1.2 \times 10^5$K, and a concentration of n = 70 cm^{-3}. During a second pass through the magnetosphere, the satellite encountered an ion concentration of 18-20 cm^{-3}, with a proton and α-particle temperature of as high as 2×10^5 K. The researchers found the solar wind to have an He^+ content 3-4 orders of magnitude higher than expected. Figures 3; references 22: 7 Russian, 15 Western.

UDC 550-383

MHD Turbulence Behind the Fronts of Quasiperpendicular and Quasiparallel Shock Waves of 2 and 7 February 1982

907Q0018E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 18 Jan 89) pp 726-738

[Article by Ye. I. Morozova, Ye. Yu. Budnik, N. F. Pisarenko, L. V. Yevdokimova, G. A. Timofeyev, K. Shvingenshu, V. Ridler]

[Abstract] The dynamics of MHD turbulence in an area of about 0.3-0.5 a.u. behind the front of the quasiperpendicular (2 Feb 1982) and quasiparallel (7 Feb 1982) shock waves are studied based on magnetic field measurements performed on the Venera-13 and Venera-14 spacecraft. The basic types of fluctuations characteristic of large-scale plasma flux structures in the shock layer and flares are analyzed for frequencies below 10^{-2} Hz. Estimates are presented of the spectral power density of magnetic field fluctuations. Two structures that differ

sharply in terms of turbulence are distinguished in the shock layer of the quasiperpendicular shock wave. In the quasiparallel shock wave, after passage through the shock front, there is a gradual increase in the power of fluctuations, with the main power concentrated at distances of over 10^{-2} a.u. from the shock front. The major feature of the area of interaction of fluxes with different velocities is the presence of broad fluctuations of magnetic field vector and modulus, particularly for the quasiperpendicular wave. In the bow region of the flare plasma flux, the fluctuations have parameters typical of Alfven turbulence. Figures 8; references 14: 3 Russian, 11 Western.

UDC 551.521.6

Heterogeneous Structure of Emission Layers of Ionosphere from Photographic Observations from Salyut-7 Orbital Station

907Q0018F Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 2 Mar 88) pp 739-747

[Article by Yu. V. Platov, N. Ya. Vanyarkha, Ye. S. Vanyarkha, G. S. Ivanov-Kholodnyy, O. Gym Den, G. M. Platova]

[Abstract] Brightness profiles obtained by photometry of photographs of the first emission layer at about 100 km altitude are compared with computed values for a model distribution of the concentration of excited atoms. The photographs studied were obtained on board the Salyut-7 in 1982 and 1985 on Ektachrome 400 and Agfa 1000 film. The model was based on the assumption that the concentration of excited oxygen atoms O(^{1}S) reaches its maximum at about 100 km altitude, then decreases barometrically with increasing altitude; below 100 km the probability of emission of the 5577 A line drops sharply as a result of elimination of excitation due to collisions and as a result of the decrease in concentration of O(I). Airglow in the model is represented as a symmetrical spot with a concentration that decreases exponentially in the horizontal direction and as a vertical distribution of concentration that has a rather sharp maximum at about 100 km altitude. The observed and calculated distributions are in good agreement. Figures 5; references 11: 6 Russian, 5 Western.

UDC 523.64

Very Long-Baseline Narrow-Band Radiointerferometry for Space Navigation. II. Orbital Vehicles; Measurement of Coordinates of Astron Satellite

907Q0018G Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 31 Oct 88) pp 765-771

[Article by V. A. Alekseyev, V. I. Altunin, A. A. Antipenko, E. D. Gatelyuk, Yu. N. Gorshenkov, A. F. Dementyev, N. A. Knyazev, A. Ye. Kryukov, V. V. Lunin, B. N. Lipatov, Ye. P. Molotov, V. A. Okmyanskiy, V. P. Pavlov, R. N. Rat, A. S. Sizov, G. V. Turusin, I. D. Tserenin, A. I. Sheykhet, and M. V. Yankovtsev]

[Abstract] An experiment that was conducted 18-23 April 1987 continued a series of experiments on the use of very long-baseline, narrow-band radiointerferometry for space navigation. Unlike the earlier experiments, which observed interplanetary vehicles, the April experiment observed the Astron satellite in near-Earth space. The purpose of the experiment was to develop an effective method for quickly determining the position in space of an orbital spacecraft in a coordinate system tied in with extragalactic radio sources. Although narrow-band interferometry is inferior to wide-band interferometry in terms of accuracy, it is simpler to use inasmuch as it does not require onboard equipment for shaping and transmitting special wide-band signals and it operates on a carrier telemetry signal that does not interfere with satellite-to-Earth radio exchange. Determination of the position of a spacecraft in near-Earth space differs from determination of the position of deep-space probes in that the wave front coming from the near-space craft is not plane, since the distances between receiving stations and to the spacecraft are of the same order. The navigational problem posed by the researchers consisted of measuring the interference frequency on a relatively small orbital segment over a time interval that was much shorter than the period of the spacecraft's revolution around the Earth. It was solved with a radiointerferometer consisting of a 64-meter antenna near Moscow and a 70-meter radiotelescope in the vicinity of Ussuriysk, in the Far East. Observations were made of signals from the transmitter aboard the satellite and from natural radio sources in the 32 cm band, with a baseline of about 6100 km, with a primarily east-west orientation. The accuracy of coordinate measurements could be increased to about 0.1" by transition to shorter wavelengths, the use of highly stable time-frequency standards, and optimization of the program of measurements. Figures 3; references 9: 6 Russian, 3 Western.

UDC 523.165

Electron Fluxes in the Breakup Region as Measured by Cosmos-426

907Q0018H Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 20 Apr 88) pp 792-796

[Article by V. Ye. Tsirs]

[Abstract] Electron flux measurements performed by the low-altitude Cosmos-426 polar satellite in the region of the magnetosphere where breakup developed are analyzed. Kosmos-426 traversed the region in the premidnight sector of the magnetosphere at an altitude of about 1,200 km, measuring fluxes of electrons with energies of $E > 20$ keV and $E > 90$ keV, E approx. equal to 62+/-15 keV, $E > 250$ keV, $E > 2$ keV, and $E = 0.2$ keV, 1 keV, 10 keV, and 30 keV during the substorm of 22 November 1971. All electrons were measured with pitch angles of approximately 90°, except for the electrons with energies of about 62 keV, which were measured with pitch angles of 0° and

90° (the latter for captured electrons). The source and location of the breakup were determined from magnetograms of zonal stations and observation of the aurora at geomagnetic latitude 64°. The breakup was observed in the region of capture of high-energy electrons near the boundary of the outer radiation belt, which was recorded as a sharp, simultaneous rise in electron flux between 0.2 keV and 2 MeV. The energy spectrum of the electrons in this range became harder at the boundary of the radiation belt. A strong decrease in intensity was observed in a narrow range of latitudes during the breakup in the fluxes of electrons with energies of less than about 1 keV beyond the boundary of the radiation belt. Figures 3; references 12: 7 Russian, 5 Western.

UDC 524.1.732

Spectrometer for Recording of Gamma Radiation from Supernova SN1987A Aboard Cosmos-1870

907Q00181 Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 10 May 88) pp 796-798

[Article by Ye. A. Devicheva, M. A. Kovalevskaya, G. V. Lupenko, N. I. Nazarova, S. P. Ryumin, A. F. Titenkov, and S. V. Shelpov]

[Abstract] The report of the explosion of supernova SN1987A in February 1987 came during preparation of an experiment for the recording of the nuclear component of cosmic radiation and moderate-energy electrons from aboard Cosmos-1870. The opportunity was seized to observe gamma radiation from SN1987A by the addition of a detector module. The researchers developed a spectrometer for recording gamma quanta in the energy range of 0.4-7 MeV. An NaI(Tl) scintillation counter crystal 60 mm in diameter and height was used as the primary detector. The crystal was surrounded by a protective detector made of a plastic scintillator 20 mm thick. The NaI(Tl) crystal and the plastic scintillator were scanned by a single FEU-125 multiplier phototube, with the signals from the detectors separated electronically on the basis of differences in scintillation time. Amplitude of the pulses from the NaI(Tl) crystal was analyzed with a 256-channel linear analyzer. Total counting rate for the gamma quanta was measured for the entire working range of energies. A flux of 5 x 10^{-4}quanta/cm^{-2}/sec^{-1} appears to represent the maximum sensitivity of the instrument. The instrument observations indicate an upper limit of the flux in the lines from SN1987A at 3 x 10^{-3} quanta/cm^{-2}/sec^{-1}. Figures 3; references 4: 1 Russian, 3 Western.

UDC 523.4

Manifestation of Orographic Waves in Atmosphere of Venus: Analysis of VEGA Balloon Experiment

907Q0018J Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 10 Nov 88) pp 761-764

[Article by M. V. Kurganskiy, V. V. Kerzhanovich, V. M. Linkin, Yu. R. Ozorovich, N. N. Pertsev, J. Blamont, R. Young]

[Abstract] Preliminary analysis of VEGA balloon experiment data received by radiotelemetry link from the gondola-borne sensors and from ground receiving stations on measurement of the Doppler frequency shift of the balloon signals showed the complex motion of the balloons in the atmosphere of Venus—calm periods of motion alternating with periods of sudden changes in the vertical component of the velocity vector with an amplitude of several meters per second. An initial comparison of the surface elevation profiles along the trajectories of the balloon probes released by the Vega-1 and Vega-2 spacecraft suggested a possible connection between surface elevation and the variations in flight altitudes of the probes. The researchers set out to evaluate the possible contribution of orographic waves to the spectrum of the vertical component of the vector velocity of the motion of the probes and to clarify the influence of relief and the sensitivity of the vertical velocity to the variations. They used a probably topography for the flight trajectory, which was formulated from available cartography data on Venus, with allowance for the nature of the relief of the Aphrodite massif. The results of numerical modeling indicate the influence of variations in relief forms on the nature of the formation of three-dimensional wave structures appearing about 54 km above the massif in the vertical component of the velocity vector. However, the computed velocity values are somewhat lower than the measured values, which may be due to problems such as nonlinear effects and imprecise data on the massif profile along the balloon trajectories. Figures 2; References 5: Western.

UDC 523.72:523.42

Density Waves in Perisolar Plasma According to Radio Transmission Data

907Q0018K Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 11 Mar 88) pp 772-776

[Article by V. P. Yakubov, O. I. Yakovlev, A. I. Yefimov, A. L. Yerofeyev, O. M. Korsak, M. A. Yerofeyeva]

[Abstract] An analysis is presented of periodic fluctuations in frequency observed in radio signals which propagated through the plasma near the sun after transmission by the Venera-15 and -16 spacecraft, in order to identify density waves in the solar wind plasma. The experiments were performed between March and September 1984, as the spacecraft passed within 2.5-110 solar radii of the sun. Results are presented from the analysis of variations in the frequency of decimeter waves ($\lambda = 32$ cm) for measurements made between May and July at two points separated by about 7,000 km. The spacecraft were 3.5-41 solar radii from the sun. Periodic frequency and phase fluctuations were observed during most observation sessions. The intensity of the periodic frequency fluctuations varied. In each 20-60 minute session, there were periods of about five minutes during which the frequency variation period T could be more clearly traced. As the heliocentric distance increased, the period T also increased. The periodic fluctuations in radio wave frequency indicate regular presence of longitudinal density waves in the solar wind plasma. Figures 4; references 13: 10 Russian, 3 Western.

UDC 551.352

Electrical Field of a Celestial Body Without an Atmosphere

907Q0018L Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 4 Apr 88) pp 777-781

[Article by V. V. Popov]

[Abstract] Based on a model similar to the one advanced by S. L. Mazurenko (Preprint No. 427, Minsk: IF AN BSSR, 1986), the researcher here analyzes the applicability of a local one-dimensional stationary model of an electric field in the vicinity of a celestial body without an atmosphere and computes the quantitative characteristics of the field, which is created primarily by solar wind and photoelectrons dislodged from the surface by solar radiation. Estimates are presented for such a body located in the orbit of Mars (Phobos), and the body is shown to acquire a positive charge. To determine the possible relationship of potential and charged-particle concentrations to coordinates, the researcher solves a Vlasov equation for electrons and a Poisson equation jointly in the system $\Delta\varphi = 4\pi e(N_e - N_p)$, where φ is surface potential, e is the proton charge, and N_e and N_p are electron and proton concentrations. Figure 1; references 7: 4 Russian, 3 Western.

UDC 551.551:523.42

Qualitative Theory of Superrotation of Venusian Atmosphere

907Q0008A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 9 Oct 87) pp 545-555

[Article by A. S. Safray and D. V. Chalikov]

[Abstract] Most of the three-dimensional mathematical models of the Venusian atmosphere successfully reproduce many of the important features of the structure of

the atmosphere—such as horizontal and vertical potential homothermia and the greenhouse effect—but the intense superrotation has yet to be explained adequately, at least in terms of the mechanism underlying it. Relying on the work of R. L. Read on superrotation and diffusion of axial angular momentum (QUART. J. R. MET. SOC., 1986, Vol 112, p 253; QUART. J. R. MET. SOC., 1986, Vol 112, p 235), Safray and Chalikov continue the discussion of the mechanism of zonal circulation in the Venusian atmosphere in the context of a convection-diffusion model for angular momentum. They advance a scenario involving a global, axisymmetric Hadley cell, with particles moving poleward from the equator in the upper branch of the cell. The particles tend to maintain their initial "equatorial" angular momentum, which becomes increasingly greater than the local solid-state angular momentum. Part of the momentum of the particles moves downward, and the particles lose their momentum with higher latitudes, but at a rate that is slower than that of the local solid-state momentum. As a result, an anomalous, equatorward diffusion flow of angular momentum develops, which causes a growth in the angular momentum of the particles in the equatorial descending branch of the cell, which are moving poleward and are part of a similar evolution. A region of angular momentum maximum maintained by the anomalous flow on its northern dip develops, the maximum is also stabilized by the normal flow of angular momentum on its southern dip in a vertical direction. Figures 5, references 16: 3 Russian, 13 Western.

UDC 551.521.8

Nonlinear Vortices in the Torus of Io

907Q0008B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 18 Aug 88) pp 556-559

[Article by A. P. Kropotkin and A. R. Mozzhukhina]

[Abstract] Among the most important features of the Jovian magnetosphere that make it different the Earth's magnetosphere are the presence of a powerful internal source of plasma—the atmosphere of Io, which is bombarded by ions of magnetospheric plasma—and the strong electric field of corotation in the plasma, which stems from the large angular rate of rotation of Jupiter and the immense radial distances. It is primarily those factors that underly the uniqueness of the physical processes in the plasma of the Jovian magnetosphere and, evidently, the typical features of the process of radial transfer of energetic particles in the radiation belt. The random electrical fields that lead to diffusional radial transfer are linked to the existence of an interchange instability that is due to the centrifugal force that is acting on the corotating plasma. The authors of this paper set out to identify the parameters of the interchange turbulence that develops at the nonlinear stage of instability, basing their search on a two-dimensional structure that consists of isolated vortices. They describe such vortices with nonlinear equations that allow for the effects of ionospheric conductivity. The estimates they derive for the typical scales of an interchange vortex and for fluctuations in the electrical field in the Io torus can also be used for determining the coefficient of interchange radial diffusion of charged particles in the Jovian radiation belts. References 9: 3 Russian, 6 Western.

UDC 551.551:523.42

Theory of Superrotation of the Atmosphere on Venus

907Q0008C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 14 Nov 86) pp 595-603

[Article by S. S. Zilitinkevich]

[Abstract] The zonal circulation of the Venusian atmosphere appears to consist of an ordered, symmetric circulation that envelopes the entire planet—a global Hadley cell—with a proper rotation that is fast enough to ensure a latitudinal variation of the thermal radiation budget and slow enough to ensure that the flow is not quasigeostrophic and a baroclinic instability does not develop. The author attempts to provide a qualitative explanation of the atmosphere's four-day circulation, otherwise known as superrotation, based on the natural tendency for swirling in a meridional circulation cell as a result of the latitudinal temperature gradient in any movement of a gaseous shell on a sphere, rotating or not. Zilitinkevich derives a partial solution for a nonlinear system of equations describing the dynamics of a nonviscous gaseous shell around a slowly rotating planet with a temperature field that varies with latitude φ as $1 + \delta(\cos^2 \varphi - 2/3)$. In comparing the model with experimental data on Venusian winds, he points out that his calculations do not take into account friction, the effects of which are fully capable of transforming a weak equatorial counterflow into a zone of attenuated superrotation and generating flows in various directions at various latitudes in the surface layer. References 13: 8 Russian, 5 Western.

Problems Associated With the Magnetic Fields of Uranus and Neptune

907Q0008D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 6 Mar 89) pp 604-616

[Article by Sh. Sh. Dolginov]

[Abstract] According to modern models of planetary interiors, Neptune and Uranus are twin planets, and data on the magnetic field of Neptune should be quite helpful in puzzling out the topology of Uranus's unusual magnetic field. (The article predates the Voyager-2 flyby of Neptune.) The researchers ask the question, Is the unique topology associated with interior features and features of the interior's electrical properties, or with the unique orientation of Uranus's axis of rotation relative to the planet's orbital plane and features of the axis's

orientation relative to the sun? The paper examines problems associated with the magnitude and orientation of the magnetic fields of Neptune and Uranus in the context of a model of a precessional dynamo and its "numerical law," and it draws on data involving the magnetic fields of the Earth and Jupiter in the process. The researchers conclude that the similarities in size, chemical composition, and models of the interiors of Uranus and Neptune do not lead one to expect similarities in the intensity and topology of their magnetic fields in a precessional dynamo model, for two reasons. First, Neptune's precession results from the influence of the massive Triton moon. It's rate exceeds Uranus's rate of "equivalent" precession by a factor of 10. Second, Uranus's axis of rotation has an anomalous inclination relative to the planet's orbit and to the sun. The researchers note that the anomalous inclination in itself cannot affect the nature of field generation without additional accompanying conditions conducive to such influence. They establish that the magnetically active region of Uranus is contiguous with fluid layers that are highly electrically conductive and may feature secondary and unusual electrical processes responsible for the anomalous topology. Based on the similarities in the models of the interiors of Neptune and Uranus, the researchers feel that, given identical temperatures and pressures, the interiors have identical electrical conductivity. Figures 1, references 31: 8 Russian, 2 Czech, 20 Western.

UDC 523.4

Radiation Entropy Influx as a Measure of Planetary Dissipative Processes

907Q0008E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 16 May 88) pp 617-626

[Article by M. N. Izakov]

[Abstract] The author demonstrates that methods involving nonequilibrium thermodynamics can be used to derive useful information on planetary dissipative processes. He concludes that the stationary-nonequilibrium state of a planet is supported by the negative entropy influx that arises when the temperature of the solar radiation is much greater than the outgoing thermal radiation. The contrast to thermodynamic equilibrium is demonstrated by the presence of large flows of energy and matter and by the fact that temperatures of matter and photons vary within a given volume of atmosphere. He suggests that a full description of planetary processes requires knowledge of the quality of incoming radiation as well as its quantity. All planetary processes are a result of the expense of negative entropy. The author notes that the influx of negative entropy on Earth and Venus matches its expense as associated with planetary processes. He points out that vertical flows of heat that maintain the temperature conditions on a planet account for most of the expense of negative entropy. References 55: 33 Russian, 22 Western.

UDC 521.313

Analytical Theory of the Motion of Phobos and Analysis of Perturbations

907Q0002 Moscow ASTRONOMICHESKIY ZHURNAL in Russian Vol 66 No 4, Jul-Aug 89 (manuscript received 15 Jul 88) pp 850-858

[Article by N. V. Yemelyanov and L. P. Nasonova, State Astronomy Institute imeni P. K. Shternberg]

[Abstract] This paper, which predates the problems that terminated the Soviet Phobos mission, presents a brief description of an analytical theory of the motion of the Martian satellite based on an adaptation of the theory of motion of artificial earth satellites. The latter theory is laid out in four earlier ASTRONOMICHESKIY ZHURNAL articles written or co-written by Yemelyanov (1985, Vol 61, p 1021; 1985, Vol 62, p 590 and p 1168; 1986, Vol 63, p 800). The authors of this paper also include research of the perturbations of Phobos's motion that is based on earlier work done by Struve, Vashkovyak, and Shor, but addresses new requirements. They achieve an accuracy in determining Phobos's coordinates of approximately 0.5 m over an interval of 1-2 years. Yemelyanov and Nasonova conclude that the secular and periodic perturbations that the Martian gravity field and the attraction of the sun cause in orbital elements must be considered when the accuracy in the determination of Phobos coordinates is 10 m. At intervals of 1-2 years, all zonal harmonics of the decay of the potential of Mars's attraction, up to and including the 12th degree, must be factored in. In perturbations caused by Deimos, only the secular components need be taken into consideration, beginning with a four-month interval. Periodic perturbations caused by the Martian tides are negligible at the given accuracy, but the secular perturbations must be allowed for, beginning with the two-year interval. Figures 2, references 13: 9 Russian, 4 Western.

Biotechnology Experiments Conducted Aboard 'Mir'

LD2903215390 Moscow TASS International Service in Russian 1447 GMT 29 Mar 90

[Text] Moscow, 29 March (TASS)—The "Rekomb" biotechnological experiment on the fusion of cells, producing biologically active substances, has been carried out in space for the first time. It was carried out during the recent 166-day expedition aboard the 'Mir' long-term orbiting complex by cosmonauts Aleksandr Viktorenko and Aleksandr Serebrov.

According to Aleksandr Serebrov, scientists are now studying the returned ampoules in order to find out how much more effectively the process of hybridization of cells takes place in a weightless environment. The cosmonaut believes that the success promises a great economic result as it will become possible to obtain new sources of biological preparations with pre-set properties.

As we have already reported, an experiment on the crystallization of proteins was carried out during the fifth mission to the 'Mir' station. American equipment was used. This was the first U.S. experiment to be accomplished aboard a Soviet space station. It was carried out on a commercial basis under an agreement with a firm called Payload Systems.

In addition, according to Aleksandr Serebrov, biotechnical experiments on the "Ruchey" installation were continued. The purposes of these experiments is to determine the effectiveness of the fine purification of insulin through electrophoresis in conditions of microgravity. Monocrystals of various proteins were also cultivated.

Biotechnical experiments on board the 'Mir' orbital complex are carried out in highly productive installations. For instance, the purification of proteins, using electrophoresis, is 1,000 times more productive than on earth.

UDC 531.28

Highly Redundant Gyrodyne Systems in Spacecraft

907Q0007I Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 30 Jan 89) pp 483-490

[Article by V. P. Legostayev and Ye. N. Tokar]

[Abstract] Choice of the number of gyrodynes *n* for a spacecraft is based on redundancy needs, which are usually met by simply adding gyro units. The number of gyro units, however, affects all the basic properties of the gyrodyne system used by the spacecraft and changes the formulation of the problems that constitute the theory of gyrodyne systems. Limiting themselves to spatial gyrodyne systems, the authors examine systems that consist of various numbers of gyrodynes, i.e., systems capable of performing the same attitude-control program for spacecraft of a given size. They examine *n* in the context of factors such as coefficient of use of kinetic moment stored by gyrodyne rotors and the relationship of gyrodyne size to rotor radius. Based on the compromise that must be reached among conflicting factors, they formulate principles for making a rational choice of number of gyrodynes. Figures 4, references 9 (Russian).

UDC 629.197.2

Studying the Problem of Orbital Gyrocompassing With Methods of the Theory of Linear Systems of Observation

907Q0007J Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 13 Jul 87) pp 502-508

[Article by S. N. Yegorov, A. F. Dyumin, and D. M. Surinskiy]

[Abstract] Orbital gyrocompasses—gyroinertial measuring devices whose position is corrected with a local vertical reference signal—are used to determine the orbital plane for an orbital spacecraft. They are also used for pinpointing the position of the local vertical and for constructing an orbital system of coordinates in the gyro stabilization mode when program maneuvers are being performed. The problems associated with the analysis and synthesis of an orbital gyrocompass are usually solved as problems of control, and the structure of the controlling assembly and the methods of compensating for the influence of measurement device errors are determined heuristically. The more natural way to solve problems associated with orbital gyrocompassing is to solve them as problems of observation, in which case formal methods of the theory of observation systems can be used not only to produce known structures of orbital gyrocompasses, but also to produce structures of observing devices of varying degrees of complexity, depending on the need to compensate for the influence of individual components of measurement errors. The authors demonstrate that the problem of orbital gyrocompassing can be solved by means of designing various observing devices. Existing gyrocompasses come under scrutiny, and the authors demonstrate the possibility of improving accuracy by using assemblies with varying instrumentation in evaluating the influence of local vertical reference errors and gyroscope drift and compensating for such influence. References 11 (Russian).

UDC 629.7.036:681.3(046)

Study of Maximum Capacities of Interorbital Tug Spacecraft with Steerable Electric Rocket Engines and Choice of Efficient Performance Modes in Flight

907Q0007 Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 28 Dec 87) pp 514-519

[Article by G. A. Kulakov, S. V. Pilyumo, and V. F. Safranovich]

[Abstract] Interorbital tug craft with electric rocket engines are space vehicles distinguished by their special performance modes and orbital transfer configurations. The features of operation of such craft and of the conditions for their use in the interorbital transport of payloads stem from the presence onboard of a power plant of a given electrical power capacity and from limitations associated with the performance characteristics of the electric rocket engines. Of practical interest is the identification of the maximum capacities of tug craft powered by electric rocket engines when the characteristics change for problems of interorbital transport of payload, initial launch mass, and power plant and the electric rocket engine parameters. The research reported here derives correlations that enable the identification of the lowest possible boundaries in terms of specific thrust of a steerable electric rocket engine. Figures 4, references 6: 4 Russian, 2 Western.

UDC 629.78

Approximate Analytical Method for Calculating Trajectory of Motion in an Atmosphere for a Spacecraft With a Propulsion System in Operation

907Q0007 Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 15 Apr 88) pp 520-527

[Article by N. L. Sokolov and Ye. G. Zhivoglazov]

[Abstract] Approximate analytical methods are widely used in Soviet practice, as well as in foreign practice, for calculating the trajectory of motion of a spacecraft in an atmosphere. As efficient as the methods are for calculating the parameters of passive flight, they do not, however, allow for the dynamic processes that accompany the motion of a spacecraft that is produced by an operating propulsion system during aerodynamic

braking. Moreover, control of motion by means of rocket-dynamic maneuvers is effective when the spacecraft is changing its plane of motion in the upper atmosphere, as well as during the execution of the complex maneuver that places a spacecraft into a satellite orbit. Consequently, it makes sense to use approximate analytical calculation methods that allow for the influence of an operating propulsion system during a spacecraft's atmospheric flight as early as the preliminary design stage. The researchers here propose an approximate analytical method for incorporating such influences in early trajectory calculation, and they use numerical examples to illustrate the efficiency of the method, which is said to have an error margin of 3%. Figures 1, references 8: 7 Russian, 1 Western.

UDC 629.7

Using Star Photometer Readings to Define Salyut-7 Rotational Motion More Precisely

907Q0007M Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 30 Mar 88) pp 528-544

[Article by V. A. Sarychev, V. V. Sazonov, M. Yu. Belyayev, N. I. Yefimov, T. N. Tyan, Ye. K. Sheffer, and V. A. Sklyankin]

[Abstract] The integrated statistical methods that were developed for determining the rotational motion of the Salyut-6 and Salyut-7 stations in the gravity-gradient attitude-control mode from sun-seeker and magnetic-sensor readings have an accuracy on a single orbit of approximately 0.5° for angular coordinates and approximately 0.0015°/s for rate of turn. Such estimates, however, which are produced in the framework of the least squares method, are optimistic. The additional information needed to produce an objective estimate can be provided from star-photometer readings. Adding the star-photometer readings to the other statistical data makes it possible not only to obtain the sought-for estimate, but also to raise the accuracy of the determination of the rotational motion relative to an absolute system of coordinates. The authors describe the mathematical models and basic algorithms underlying the complex of programs run on the BESM-6 computer for processing the measurement data from all the sensors, including the star photometer. The station (to which either a Soyuz transport craft or a Progress freighter is docked) is considered a solid body whose center of mass moves along a near-circular geocentric orbit. Three right-handed Cartesian coordinate systems are used to write equations of motion for the station relative to center of mass. The authors demonstrate the potential of the program complex and, in an appendix to the article, examine the precision with which the station's motion is determined when the photometer tracks one star. Figures 5, references 5 (Russian).

UDC 621.352.6:519.863

Complex Optimization of Power Plant With Electrochemical Generator and Temperature-Control Systems on a Spacecraft

907Q0007N Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 4, Jul-Aug 89 (manuscript received 23 Jun 87) pp 560-567

[Article by M. A. Kuzmin]

[Abstract] An autonomous power system is a complex of subsystems that produce, convert, and distribute energy and mass flows aboard a spacecraft. Its purpose is to supply electrical power and provide temperature control for certain onboard systems; its two components are the power supply system and the temperature-control system. The author develops a procedure for optimizing the design parameters of an autonomous power system that consists of a power plant equipped with an electrochemical generator and a temperature-control subsystem. The mathematical model he presents for the power system assumes linearity of the generator's volt-amp characteristics, generator current efficiency independent of choice of operating point, and specific mass and energy characteristics independent of the design parameters of the power system elements. The power supply system includes fuel and oxidizer reservoirs and a reaction-product collector. Figures 4, references 2 (Russian).

UDC 629.78

Stabilization of Satellite with Flexible Rods. I.

907Q0019A Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (Manuscript received 7 Apr 88) pp 643-651

[Article by S. I. Zlochevskiy, Ye. P. Kubyshkin]

[Abstract] A mathematical model presented in an earlier work by the same authors (KOSMICH. ISSLED., 1987, Vol 25, No 4, pp 537-544) is used to solve the problem of stabilizing the angular position of a satellite bearing two flexible rods; the entire oscillating spectrum of the rods is considered. The satellite is represented as a compact solid with two elastic, symmetrically positioned cantilever rods of length l and uniform cross section. Mass distribution is uniform. The point of attachment for each rod is a given distance from the center of mass of the solid. The satellite has an attitude-stabilization reaction-propulsion system. The authors solve a boundary value problem associated with plane, elastic oscillations of the rods to construct the region of stability in the plane of parameters (n_2, n_3/n_1, demonstrating that this area is only a portion of the region of stability constructed for a satellite with rigid rods. Figures 2; references 6: 5 Russian, 1 Western.

UDC 629.19.086

Mathematical Modeling of Errors in Acquisition of Trajectory Information on Moving Objects from Space Stations

907Q0019B Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 29 Feb 88) pp 660-665

[Article by S. A. Leonov]

[Abstract] Highly accurate electronic information-gathering equipment is used on satellites to obtain trajectory information with regard to moving objects. The main contribution to the error of trajectory measurements is that of external factors, resulting from the placement of the measurement equipment on an oscillating, deforming platform moving through space. Creation of a mathematical model based on a formalized description of the errors can significantly facilitate computations to determine the requirements for future information-gathering systems. This article suggests mathematical models for these errors and describes the spatial properties of the errors. Figure 1; references 7: Russian.

UDC 629.78

Features of the Processing of Measurements in a Problem of Navigation of a Reentry Vehicle

907Q0019C Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5 Sep-Oct 89 (manuscript received 12 Feb 88) pp 666-673

[Article by N. M. Ivanov and S. I. Kudryavtsev]

[Abstract] Evaluation of trajectory parameters from relative measurements is of fundamental importance in ensuring the highly precise landing of a reentry vehicle through radio control with a ground-based tracking station. The article looks at the features of radio measurements for controlling the motion of a reentry vehicle and for producing an effective algorithm for processing the measurements. Its authors set out to estimate the reentry vehicle trajectory parameters needed to assure proper functioning of radio-control algorithms. An adaptive filtration algorithm is produced for determination of errors in a dynamic system model, and its effectiveness is demonstrated for estimating the parameters of the descent trajectory for a vehicle with a low lift/drag ratio after reestablishing communications with the ground. The influence of random measurement errors on the accuracy of solution of the navigational problem is significantly reduced. Correction of the *a priori* covariation matrix of estimation errors by the Lyapunov method makes the filter flexible and effective for computation. Figures 2; references 10: 9 Russian, 1 Western.

UDC [629.7.048.7+621.57]:519.863

Optimization of Autonomous Closed-Loop Thermostatting System

907Q0019D Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 23 Oct 87) pp 674-681

[Article by M. A. Kuzmin]

[Abstract] Thermostatting systems remove the excess heat from spacecraft systems, in order to maintain constant temperature. The closed-loop thermostatting systems that are used on spacecraft recycle heat-transfer fluid and consist of a refrigeration unit, a power source, and a refrigeration-radiator element. An increase in the temperature of the heat transferred to the surrounding environment makes it possible to decreases the necessary area and mass of the refrigeration-radiator element, but requires increased refrigeration-unit and power-source mass, which indicates that there should be an optimum temperature of heat loss to minimize total system mass. The authors construct a mathematical model of an autonomous thermostatting system in order to determine the optimal parameters of such a system and obtain a solution in dimensionless parameters. They study the influence of conditions of thermostatting and design characteristics of system elements on the optimal temperature of the cycle, as well as the optimal ratio of system element masses. Figures 5; references 2 (Russian).

UDC 629

Synthesis of Control Signals With a Predictive Model in Spacecraft Control System with Relay-Type Actuators

907Q0019E Moscow KOSMICHESKIYE ISSLEDOVANIYA in Russian Vol 27 No 5, Sep-Oct 89 (manuscript received 6 May 88) pp 682-690

[Article by N. Ye. Zubov]

[Abstract] The researcher here examines a problem involving the synthesis of optimal control of a spacecraft, which is represented as a nonlinear object. The method of synthesis he proposes extends to the control of objects with relay-type actuators. He examines it in the context of an example that involves the rendevous of two approaching spacecraft, in which the rendevous plane is plotted and stabilized and the influence of the gravitational field on the relative motion of the spacecraft is negligible. The algorithm the author proposes is a modification of an algorithm he advanced in an earlier work published with V. N. Bykov (AVTOMATIKA I TELEMEKHANIKA, 1986, No 6, pp 36-42). In terms of continuous processes, the algorithm proposed here, unlike the earlier algorithm, involves control of the position of the actuators and employs a large number of engine switch-ons, which means the algorithm is useful only if there is no constraint on the number of switch-ons or if the constraint allows a high number of switch-ons. Figures 2; references 5 (Russian).

Izhevsk Plant Produces Satellite Navigation Equipment

LD1203093990 Moscow Television Service in Russian 0930 GMT 11 Mar 90

[From the "Vremya" newscast]

[Summary] Our Udmurt correspondent reports on the output of Izhevsk radio plant, which previously was received only by restricted departments but is now intended for the most varied type of specialists.

[Begin correspondent recording] It would seem that the first steps have been taken. Judge for yourselves. Journalists' cameras have never previously operated in this workshop of the Izhevsk radio plant association, although we have visited the enterprise several times.

You see before you a compact complex of satellite navigational equipment. Specialists assess it as being up to world standards. At any moment a navigator may determine the coordinates of his ship to within a few meters and stay precisely on course. Now the new Izhevsk complex may be used not just by the Navy but also by the crews of ships belonging to other departments. [video shows various elements of the satellite-navigational equipment, designated "ADK-4M"]

Another item of equipment developed in Izhevsk is a telemetric system of gathering information. It could become a dependable assistant for drivers, rail workers, aviators, and seamen. The accuracy and up-to-date nature of the telemetric information are, as they say, guaranteed. Moreover the equipment may also be used to monitor the condition of patients. [video shows telemetric information equipment with display showing the words "dangerous hurricane"]

Other products of the association includes the most diverse types of household stereophonic equipment, a personal computer, electronic equipment for Jacquard textile looms, and various types of medical apparatus. [video shows stereophonic and other equipment]

The association's present plan for output of goods has been increased by almost R20 million. [end recording]

Scientific Director on 'Marafon' Communications Satellite System

LD0304114990

[Editorial Report] Moscow Domestic Service in Russian at 1115 GMT on 2 April broadcasts a 13-minute program entitled "Topical Interview: Space Communications, New Horizons", in which special correspondent Leonid Lazarevich interviews Doctor of Technical Sciences Aleksandr Petrovich (Radimov), chief designer and director-general of the Astra scientific production association. (Radimov) asked about plans to develop a new system of satellite communications—the Marafon (Marathon) system—stresses the importance of developing an efficient communications system in the Soviet Union.

He quotes the USSR minister of communications, who at the Congress of People's Deputies underlined the importance of creation of space communication systems, to be more precise, satellite systems. Developing communications networks by cable systems alone will not solve the requirements of telephone and other communications systems in the USSR, he says. Problems of financing all programs of communication make it necessary to turn to commercial systems of communication.

(Radimov) continues that Comrade Erlen Kirikovich Pervishin, USSR minister of communications and Oleg Nikolayevich Shishkin, USSR minister of general machine building have already signed a decision on setting up an association of enterprises aimed at solving the task of developing a commercial satellite communications system. The priority should be given to the development of a system of communication with mobile objects. Overall calculations show that there is a demand for 150-200 thousand mobile and semi-stationary communications sets by the Ministry of the Maritime Fleet, fishing fleet, river fleet, and to a greater degree by the Ministry of Railways and the Ministry of Civil Aviation, Ministry of Geology, and some others.

(Radimov) says the Marafon system enables communications equipment for making telephone calls and sending telexes to be installed on all aircraft, trains, and motor vehicle transport. This opens up opportunities to prevent loss of containers and wagons; for example, a type of equipment for containers has been developed, costing somewhere up to R1,000, which enables telecoded information to be transmitted.

(Radimov) answers a question from Lazarevich, saying the work of Energiya scientific production association in launching large communications platforms will not be hampered by the development of the Marafon commercial system of communication, though there is cooperation between the enterprises on this program. Main communications systems such as television broadcasting are at present a state monopoly: the Marafon is a commercial system.

(Radimov) says that the Marafon system will consist first of all of central stations of control and commutation, situated on earth, then base stations and subscriber stations. Then there must also be a control and measuring complex and a space segment, which will include three satellites in stationary orbit and two sets of four satellites in elliptic orbit.

He says financing of the system can be done on various bases by credits, by creating a joint-stock company, by an association of banks purchasing the space segment. About R72 million from various organizations and government departments has been offered to the Marafon system so far. Preparations for production are under way

at the manufacturing factories. (Radimov) gives a guarantee that the system will start functioning on 1 January 1993. Defense ministries subject to conversion over the last year, or which are yet to undergo conversion are offering their services to the Marafon developers, though there must be an appropriate technological base and trained staff: in each specific case a working group can be set up to examine the possibility of any enterprise participating in the Marafon project.

Use of Satellite SLR Data Discussed at Varna Conference

907Q0032A Moscow NTR: PROBLEMY I RESHENIYA in Russian No 21, 1989 (Signed to press 3 Nov 89) p 3

[Article by A. I. Kalmykov, doctor of physical and mathematical sciences and department head of the Ukrainian SSR Academy of Sciences' Radio Engineering and Electronics Institute: "Space-based Prediction of Catastrophes"]

[Text] **The Bulgarian Academy of Sciences's Electronics Institute hosted the Sixth International School on Microwave Physics and Equipment, 2-7 October, in Varna. Leading specialists from the USA, Finland, Italy, Japan, the FRG, and France participated in the forum.**

The report by the research associates from the UkSSR Academy of Sciences's Radio Engineering and Electronics Institute (Kharkov) A.I. Kalmykov, V.N. Tsymbyl, S.A. Velichko, N.V. Zubenko, Yu.A. Kuleshov, and N.A. Oleynik, the core of which was the theme "Radar Observations from Space of Critical Phenomena and Natural Catastrophes in the World Ocean," riveted everyone's attention.

The report was of interest not just to the specialists. Now, when a discussion has sprung up in our society about the advisability of outlays for space research, this research effort has evidently been able, to some degree, to cool the ardor of the proponents of the "grounded approach" to spending for space.

Let us hear what A.I. Kalmykov, doctor of physical and mathematical sciences, department head of the UkSSR Academy of Sciences's Radio Engineering and Electronics Institute, and director of the effort, has to say.

I will begin a condensed summary of our report, if I may, with an episode whose "happy ending" is widely known to the readers of publications in the mass media.

In 1985, the science expedition ship Mikhail Somov had been drifting for nearly four months in a field of pack ice 4-6 m in thickness. Finally, the situation became critical. The icebreaker Vladivostok, on its way from New Zealand to assist the Mikhail Somov, ran into a fierce storm. Some 180 barrels of kerosene for the helicopters that were supposed to evacuate those aboard the drifting vessel were washed overboard from the icebreaker's deck. The planned operation was on the brink of a catastrophe.

The leader of the expedition decided on a risky solution, but one that, as it turned out, was the only practical solution: break through to the Mikhail Somov through one of the channels found by Kosmos-1500's radar. The icebreaker wasn't strong enough to handle ice thicker than 1.5 m. That is, it could proceed through the channels only.

They were tracked throughout the entire polar night on images obtained from the side-looking radar (SLR) of the Kosmos 1500-series satellite (Okean) which we had developed. From April to June, the Hydrometeorological Service and the UkSSR Academy of Sciences's Radio Engineering and Electronics Institute systematized information on those channels. It was established that they are stable and long-lasting. Based on the dynamics of their changes, we also managed to determine the rate of drift of the ice pack.

On 24 Jun 85, the Vladivostok entered into a channel found by the Kosmos-1500. And in a little over seven hours, it proceeded nearly 60 miles through almost clear water. That was a turning point. The entire operation—not just the rescue of the people, but also getting the Mikhail Somov out of the ice—took less than five days.

Another example. A year earlier, in August and September, we were periodically observing the region of the Caribbean Sea. On 22 August, we detected a spiral-shaped velocity field of a "driving" wind with a poorly developed "eye" in a radar image and a corresponding spiral cloud structure, while on 11 and 12 September, we detected the classic manifestation of Hurricane Diana approaching shore near the city of Wilmington. Based on the radar data for 11 September, a determination was made of the distribution of the velocity of the "driving" wind. The power of this hurricane amounted to $P = 1.2 \times 10^8$ MW. It was the most powerful one that year. Our warning turned out to be timely.

The equipment's high sensitivity makes it possible to use radar data to efficiently determine wind velocity, which was decisive in the "Wilmington Case," and also to investigate various types of inhomogeneities, including the detection of oil spills.

More than five years of experience in the operation of SLR and satellites of this series (Kosmos-1500, 1602, 1766 and Okean) have confirmed the advantages of SLR both for oceanic research and for studying sea ice and glaciers.

Based on similar systems installed both on umanned satellites circling in a polar orbit and on the long-duration Mir orbital station and 1870-type satellites, it is possible to create real-time operational systems for detecting critical phenomena and natural catastrophes.

This idea of ours has received the support of our American colleagues. Their interest in this development of the UkSSR Academy of Sciences' Radio Engineering and Electronics Institute, arose, it seems, after our prediction

of Hurricane Diana. The fruitfulness of our cooperation with them has also been recognized in direct talks with NASA representatives.

Raduga Communications Satellite Launched 15 Feb

LD1602094590 Moscow TASS International Service in Russian 0900 GMT 16 Feb 90

[Text] Moscow, 16 Feb (TASS)—A routine Raduga communications satellite was launched in the USSR on 15 February, 1990 by means of a Proton carrier rocket. It has onboard retransmission apparatus intended to ensure telephone and telegraph radio communication and the transmission of television programs.

The Raduga satellite has been put into a near-stationary orbit with the initial parameters:

—distance from the surface of the earth 35,903km;
—period of rotation around the earth 24 hours 4 minutes;
—inclination of orbit 1.3 degrees.

The apparatus installed on the satellite is working normally. The command and measurement complex is carrying out control of the satellite. Exploitation of the communications and television apparatus of the satellite will be carried out in accordance with the planned program.

'Okean' Oceanographic Satellite Launched 28 Feb

LD2802115890 Moscow TASS International Service in Russian 1050 GMT 28 Feb 90

[Text] Moscow, 28 Feb (TASS)—An Okean artificial earth satellite was launched in the Soviet Union today by a Tsiklon booster.

The basic task of the launch is to receive current oceanographical information and data on ice conditions in the interests of various branches of the USSR national economy and international cooperation.

The satelite was launched with the following parameters:
—maximum distance from earth's surface (apogee)—679 km
—minimum distance from earth's surface (perigee)—655 km
—inclination of orbit—82.5 degrees
—initial period of orbit—97.8 minutes.

The satellite is carrying sets of scanning, optical-mechanical, and radiophysical apparatus.

Information from the satellite is being received for processing and distribution at the State Research Center for the Study of Natural Resources and at autonomous centers for receiving information belonging to the USSR State Committee for Hydrometeorology.

'Nadezhda' Navigation Satellite Launched 27 Feb

LD2802113290 Moscow TASS International Service in Russian 1046 GMT 28 Feb 90

[Text] Moscow, 28 Feb (TASS)—A Nadezhda artificial earth satellite was launched in the Soviet Union on 27 February 1990 by a "Cosmos" booster.

The satellite carries apparatus of a navigation system for determining the position of vessels of the USSR's maritime and fishing fleets, and also apparatus for work within the international space system for the search and rescue of vessels and aircraft in difficulties (KOSPAS-SARSAT).

The satellite has been placed in an orbit with the following parameters:

initial period of revolution, 104.9 minutes;

apogee, 1032 km;

perigee, 975 km;

orbital inclination, 83 degrees.

The apparatus aboard the satellite is woking normally. The coordinating and computing center is processing the incoming information.

'Foton' Satellite Launched 11 Apr

LD1204075190 Moscow TASS International Service in Russian 0722 GMT 12 Apr 90

[Text] Moscow, 12 April. (TASS)—On Wednesday another "Foton" earth satellite was launched in the Soviet Union by means of a "Soyuz" carrier rocket. The satellite is designed for the continuation of research into space materials.

The program of the flight, estimated for 16 days, envisages the carrying out of experiments in obtaining, under conditions of micro-gravitation, crystals of proteins and semiconductor materials with improved properties, and also development of the technology of their experimental-industrial manufacture.

By commercial agreement the "Foton" satellite also carries research equipment of France's National Center for Space Research.

After the planned flight program has been completed the materials obtained will be delivered to earth and conveyed to scientific organizations for research.

The equipment installed on the satellite is working normally.

The coordinating and computing center is processing the incoming information.

UDC 551.465:629.78

Retrieval of Water-Body Surface Temperature From Data of UHF Remote Sensing

907Q0017A Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 10 Feb 88) pp 14-22

[Article by K. Ya. Kondratyev, V. V. Melentyev, and V. A. Nazarkin, Limnology Institute, USSR Academy of Sciences, Leningrad; Special Design Bureau, Moscow Power-Engineering Institute]

[Abstract] One method of raising the reliability of the retrieval of the surface-layer temperature of a water body from remote sensing data involves the use of the correlation method of retrieval that is based on the joint analysis of the data of spectral-polarization microwave measurements made from various platforms, reference data on the retrieved surface-layer temperatures, and background characteristics associated with the state of the underlying surface-atmosphere system. The researchers identified the optimal conditions for sensing by performing massive computer calculations of radiothermal emissions of the water-surface/atmosphere system, and they used them to produce estimates of the variability of outgoing microwave radiation as a function of parameters that characterize total radiobrightness temperature and its components. The calculations were performed for a flat, layered model of the atmosphere that used standard distributions of temperature and pressure for statistical models of the atmosphere, as well as specific vertical profiles of temperature, pressure, and absolute humidity constructed from airborne and surface measurements. Sea state geometry and foam associated with wind-wave breaking were taken into consideration. The researchers used the so-called two-channel sign-contrast method for determining temperature anomalies in surface layers of salt water and fresh water. Results are presented for a sector of the Pacific from 42°N to 42°S, 135°E to 129°W. Figures 5, references 6: 5 Russian, 1 Western.

UDC 551.51 (321.7)+551.467+528.72 (202)+629.78

Analysis of Radar Images of Greenland Ice Cover

907Q0017B Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 19 Apr 88) pp 23-30

[Article by M. V. Bukharov and Yu. G. Spiridonov, USSR Hydrometeorological Scientific Research Center, Moscow]

[Abstract] Satellite-based remote sensing that produces radiothermal and radar images of the Earth's surface on a regular basis and in all weathers is opening new horizons for the identification and study of patterns of variation of properties and conditions associated with inaccessible ice areas of the Antarctic and Greenland. Existing models that explain the features of such images, however, use several parameters in which possible changes cannot always be clearly determined. The work reported in this paper analyzes the features of above-ice and below-ice relief on radar images of Greenland made in the spring and autumn of 1987. The analysis is performed in the context of a volume scattering model. The authors conclude that the geometry of large areas with homogeneous scattering that are delineated on the images is clearly associated with the above-ice relief and the elevation of the zero summer isotherm. A sharp reduction in the scattering properties of the ice cover is observed in the ice areas located 0.6-0.8 km above the zero July isotherm. An analysis of models of volume scattering of radar signals suggests that the most critical parameter in terms of quantitively explaining the sharp drop in scattering that was observed above the zero summer isotherm is the average size of the scattering grains or the radius of correlation of inhomogeneities of the dielectric constant of the cover. The agreement they noted between, on the one hand, the spatial position and the directions of the scattering inhomogeneities that are typical of the northeastern region of the ice area and, on the other, the position and directions of the isolines of below-ice relief elevations can be attributed to the growth with depth of average sizes of scattering particles and, consequently, of the magnitude of scattering of the radar signal. The bands of inhomogenous scattering may be considered a result of the varied thickness of the upper, weakly scattering layer of snow cover; the thickness is a function of the leveling horizontal transport of snow by the wind and of the magnitude of the uplift of the entire layer of moving ice in the rounding of mounds of the below-ice relief.

UDC 535.243.25:519.22+629.78

Use of Spectrometry and Spectropolarimetry in Identifying Agricultural Geosystems and Estimating Their Condition

907Q0017C Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 8 Jan 88) pp 52-59

[Article by V. B. Malyshev, V. A. Zaytseva, S. I. Kononovich, P. V. Komar, and S. G. Sinyakovich, Institute of Geography, USSR Academy of Sciences, Moscow; Institute of Physics, BSSR Academy of Sciences, Minsk; Scientific Research Institute of Applied Physical Problems imeni A. N. Sevchenko, Minsk]

[Abstract] The optical properties of a geosystem that appear when solar radiation interacts with the system represent a comprehensive characteristic that reflects the integral properties of the system. The researchers performed experimental studies of the spectral and polarization characteristics of geosystems of the central forest-steppe region at the Kursk aerospace testing region of the USSR Academy of Sciences Institute of Geography. They used the MSS-2P spectropolarimeter operating in the 0.42-0.78 μ range and the Skif spectrometric microprocessor system operating in the 0.385-1.14 μ range.

Relative error in the measurement of spectral density of luminance and spectral luminance factors was 5-7%. Error in estimating the degree of polarization P was +/-0.04. Studies of spring and winter wheat, barley, corn, sugar beets, and oats led the researchers to the following conclusions: simultaneously obtained spectral and polarization characteristics increase the reliability of the identification of classes of agricultural systems of similar condition when three-dimensional space is used—including the degree of polarization P at wavelengths of 460 and 740 nm—as well as the vertical vegetation index. An analysis of the relationship between phytometric parameters and spectral and polarization characteristics that was based on barley suggests that the main phytometric parameters affecting the spectral luminance factor of the plant cover during the period of lactescent-yellow ripeness are total leaf surface, total weight of biomass, and overall projective covering (spectral intervals of 0.44-0.47, 0.55-0.58, 0.67-0.68, and 0.72-0.73 μ are best for determining such parameters). Degree of polarization in the range 0.46-0.68 μ is most closely linked to total leaf surface, total crop weight, and total field-growth weight. Between 0.50 and 0.55 μ, an increase in total leaf surface is associated with a reduction in degree of polarization. Between 0.58 and 0.62 μ, degree of polarization is linked to moisture content of the plants. Atmospheric haze and its denseness were shown to affect the spectral distribution of the radiation reflected and scattered by the crops and produce intense variations in spectral and polarization characteristics. Figures 5, references 15: 11 Russian, 4 Western.

UDC 631.1:629.78

Interactive Processing of Multiband Aerial Photographs for Studying the Condition of Farm Crops

907Q0017D Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 17 Dec 87) pp 60-64

[Article by Ye. Rumenina, N. Pelova, and N. Achkov, Central Laboratory of Space Research, Bulgarian Academy of Sciences, Sofia]

[Abstract] The work reported in this paper involved the use of multiband aerial photos taken with the MKF-6M camera to identify certain farm crops in the southern portion of the Kursk region, within the Medvenka-Solntsevo testing grounds (the Kirov kolkhoz), and to evaluate crop condition. The photos spanned two successive vegetative phases. Double positives were processed of fields of winter wheat, sugar beets, oats, corn, and fallow soils. The results of ground-based measurements from the initial data of the Kursk-85 experiment were used for interpreting the analysis. The researchers performed a quantitative analysis of soil cover and determined parameters of vegetation phase, biomass, and harvest. The double positives were digitized with an Optronics-C-450 scanner-plotter. The information was recorded on magnetic tape and fed into the data base of the 2RAAK-300V interactive system. Histograms were used to convert the initial images in each channel, in order to improve their visual qualities. The researchers concluded that interactive processing of the photos works well in the classification of plantings of various crops. Early summer images can be used to determine the species, condition, and expected harvest volume of winter wheat as a function of soil and climatic conditions and farming techniques. The photos can also be used to distinguish soil subtypes. Figures 2, references 2 (Russian).

UDC 551.25:629.78

Use of Space-Based Surveys by the Transport Construction Sector

907Q0017E Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 13 Jan 88) pp 74-80

[Article by V. B. Dostovalov and M. S. Naumov, Moscow State Design Institute of Transport Construction]

[Abstract] The use of space-based surveys for the survey and planning operations associated with railroad construction offers obvious advantages owing to factors such as the expansiveness of the areas involved, the abundance of geomorphological factors that affect engineering operations, the large scale of structures that must be built and the capital involved, and the need to produce forecasts of changes that occur in natural conditions in the course of the construction and operation of railroads. The researchers outline the fundamental principles underlying the use of space surveys in railroad construction. They point out that space-based surveys produce information on structures that constitute the primary content of engineering-geological maps, e.g., bedrock formations and lithogenetic complexes, folded structures and fractures. The space-based materials accommodate the different stages of railroad construction with varying detail and various types of survey (e.g., photography, multiband surveys, radar surveys), and they provide information on seasonal variations in a given area and on relatively inaccessible areas. The researchers conclude that use of space-based survey materials lowers costs, shortens the time needed for operations, and enables the adoption of the best design solutions. Figures 2, references 6 (Russian).

UDC 551.46.062.3:551.463.5

Statistical Characteristics of Outgoing Shortwave Radiation

907Q0017F Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 10 Nov 87) pp 81-87

[Article by T. B. Zhuravleva and G. A. Titov, Institute of Atmospheric Optics, Siberian Division, USSR Academy of Sciences, Tomsk]

[Abstract] In earlier work, the researchers examined mathematical models of broken cloud cover and solved dispersion and correlation function equations for solar radiation intensity (ISSLED. ZEMLI IZ KOSMOSA, 1989, No 4, pp 35-43). In yet earlier work, they detailed the relationship between average radiation field and the optico-geometric parameters of cloud cover and the zenith angle of the sun (IZV. AN SSSR. FIZIKA ATMOSFERY I OKEANA, 1987, Vol 23, No 7, pp 733-741). Their use of histograms of average intensity of scattered light for estimating the average radiation intensity recorded by narrow-angle receivers, however, can lead to errors. For receivers with a field of vision angle of about 10^{-3} radians, the angular dependence of the radiation can be ignored, and the average characteristics of a radiation field in the direction coinciding with the optical axis of the receiver can be estimated. In the work reported here, the researchers study the statistics associated with the intensity of radiation outgoing to zenith, and they discuss the possibility of passive remote sensing of cloud fields. They demonstrate that the variability of radiation characteristics such as dispersion and average intensity is determined primarily by variations of geometric parameters of cloud fields, and not by variations in microphysical parameters. Figures 5, references 7: 6 Russian, 1 Western.

UDC (551.521.14+525.22):629.78

Experimental Studies of the Radiation Characteristics of Ground Covers in the UHF, IR, and Visible Ranges

907Q0017G Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 (manuscript received 17 Dec 87) pp 98-105

[Article by A. G. Grankov, B. M. Liberman, A. A. Milshin, F. A. Mkrtchyan, V. M. Polyakov, Ye. A. Reutov, A. V. Rossiyskiy, V. P. Savorskiy, A. A. Chukhlantsev, and A. M. Shutko, Institute of Radioengineering and Electronics, USSR Academy of Sciences, Moscow]

[Abstract] Numerous studies have established that the electromagnetic reradiation (scattered radiation) of ground covers in the frequency range extending from visible waves to radiowaves bears information on parameters such as soil temperature and moisture content, biometric and geometric indices of vegetation, and the degree of roughness of ground (or water) surfaces. The work reported here presents the results of experimental studies of the statistical interrelationship of reradiation field characteristics of certain types of natural structures in the UHF, IR, and visible ranges. The studies were performed with data from the Gyunesh-84 and Kursk-85 experiments. The researchers focus on the compatibility of the remote sensors used and its effect on measurement and interpretation; the differentiation of natural situations and structures on the basis of the criterion of dependence (or independence) of the statistical characteristics of natural electromagnetic fields; and the possibility of estimating the condition of natural structures on the basis of the ratio of radiation contrasts and typical spatial scales of electromagnetic fields. The measurement data were obtained with equipment carried aboard an An-2 flying laboratory—a Soviet 3-channel UHF radiometer, a Soviet 1-channel IR radiometer, and a GDR 8-channel Barness visible/IR spectrometer—to survey inland water bodies and agricultural geosystems from altitudes of 50-100 m. The researchers found a weak correlation between UHF and IR radiometer and optical measurements on ground sectors covered with early-stage vegetation. The UHF radiation characteristics and their variations were determined primarily by moisture content, whereas the IR characteristics were determined by type of plant cover and its biometric indices. Sectors exhibiting a strong link between UHF radiometer and optical measurements—uncovered soils, thick vegetation—can be used as test sectors for identifying regression dependences in order to extrapolate individual measurements in one spectral range from data of continuous measurements in another spectral range. UHF, IR and visible data can be used to differentiate certain types of natural structures (winter wheat in the milky ripeness stage, oats in the heading stage, sugar beets in the sprouting stage, alfalfa in the flowering stage, arable land not requiring irrigation, and natural water bodies) and to ascertain their conditions when soil moisture, biometric indices of vegetation, and temperature and mineralization of water surfaces vary. Figures 6, references 3 (Russian).

UDC 502.3:629.782

New Volume of the Atlas 'Interpreting Multiband Aerospace Photographs'

907Q0017H Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 pp 117-119

[Article by G. A. Avanesov, Ya. L. Ziman, Yu. F. Knizhnikov, V. I. Kravtsova, K.-Kh. Marek, and G. Fridlyain]

[Abstract] The second volume of the atlas "Interpreting Multiband Aerospace Photographs" was published in 1988 by the GDR house Akademi-Ferlag (Berlin) and the Nauka house (Moscow). It is devoted to the geographical-cartographic and economic applications of space-derived information—high-resolution, multiple-frequency-band scanner images received by radio link from satellite. The book was prepared by Soviet, GDR, and Bulgarian specialists, with the bulk of authorial, editorial, and organizational work done by the USSR Academy of Sciences Institute of Space Research, the geography faculty at MGU, and the GDR Academy of Sciences Central Institute of Terrestrial Physics and Institute of Geography and Geoecology. The tome is published in Russian, German, and English and is based on a survey of the Earth's surface done with the Fragment scanning system. The introductory section of the atlas includes characteristics of the Fragment system and the equipment for transmitting, receiving, and recording data. The body of the atlas contains the results and

procedures of thematic interpreting of images, and a special section is devoted to multifaceted research.

UDC 001.83(100):629.7:525

Second Soviet-Bulgarian Manned Flight. Experiments in Remote Sensing of the Earth

907Q00171 Moscow ISSLEDOVANIYE ZEMLI IZ KOSMOSA in Russian No 5, Sep-Oct 89 pp 120-121

[Article by L. A. Vedeshin]

[Abstract] The second Soviet-Bulgarian manned space mission was a 10-day expedition that took place 7-17 June 1988. A crew of A. Ya. Solovyev, V. P. Savinykh, and Bulgarian A.P. Aleksandrov went aloft aboard the Soyuz-TM, which docked with the Mir space station. The mission's science program included experiments in aerospace medicine and biology, space physics, remote sensing of the Earth, and space-based materials science. The remote sensing program—Georesurs—involved a three-prong survey of parts of Bulgaria, the Soviet Union, and the Pacific Ocean performed simultaneously with photographic, spectrometric, and colorimetric equipment aboard the Mir station. The KATE-140 stationary topographic camera and the Spektr-256 unit, plus portable cameras and the Tsvet colorimeter, were used for the remote examination of Bulgaria. The Staraya Planina, Chernoye More, Frakiya, Les (Pila), and Miziya experiments measured color-response/reflective characteristics for the purpose of solving procedural problems associated with interpreting space-derived images and for mapping purposes. The Atmosfera-2, Zarya-2, Terminator, and Limb experiments studied the optical characteristics of the atmosphere and produced data on the distribution of atmospheric aerosol. Experiments labelled Kontrast and Zagryazneniye involved procedural problems in the study of atmospheric pollution and the identification of the best means of recording it, whereas those called Tsvet and Tsvetovoye Vospriyatiye performed colorimetric studies and analyzed color perception of individuals making visual observations. The color-response/reflective characteristics of Mir station viewports were studied in the Illyuminator experiment, which was partly intended for spectrometer calibration. Synchronous ground-based and airborne subsatellite experiments were performed during the mission aboard Mir.

Dunayev Outlines 1990 Space Program

LD3003205890 Moscow TASS International Service in Russian 1410 GMT 30 Mar 90

[Text] The launch of the "Kristall" technology module which is to become a component part of the Soviet long-term orbital complex, "Mir" has been postponed from 9 to 18 April. This was reported today at a briefing at the Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research [Glavkosmos], by the head of that body, Aleksandr Dunayev.

According to Dunayev, two more manned flights to the "Mir" station are planned this year. Five "Progress" freight craft are also to be launched. Aleksandr Dunayev reported that around 200 million rubles, that is, 80 million less than last year, have been allocated this year to carrying out the national Soviet manned flight space program. According to Dunayev, this put Glavkosmos in an extremely awkward situation in which it is forced to look for the money it lacks.

It was reported at the briefing that in the middle of this year there are plans to launch the "Almaz" artificial earth satellite to study the planet's natural resources. It is proposed to launch the artificial earth satellites "Resurs F" and "Okean O" and other automatic space equipment in the interests of various sectors of the USSR's national economy.

The "Gamma" astrophysical observatory will also be launched this year. This event has been delayed for the last few years, the head of Glavkosmos said.

According to Aleksandr Dunayev, the "Gals" satellite will be put into geostationary orbit at the end of 1991-beginning of 1992. It will be the first of a series of space apparatus to provide transmission of the first and second all-union programs of Central Television throughout the entire territory of the USSR in continuous broadcasting mode.

Dunayev Discusses Space Program Plans for 1990 and Beyond

LD1204103290 Moscow Domestic Service in Russian 0800 GMT 12 Apr 90

[Text] On Cosmonautics Day, we usually sum up the work that has been done and the planned experiments, expeditions, and launches of national economic satellites. Today, we are not going to depart from this tradition, so here is our correspondent Andrey Zelentsov.

[Begin recording] [Zelentsov] I would like to draw your attention right away, comrades, to the fact that until recently it was absolutely impossible to tell you about future space flights and forthcoming launches. But now, the USSR Glavkosmos considers it quite permissible to speak about even the long-term program. To this end, a news conference was recently held at which the journalists were acquainted with the plans for this year and for the near future as well. To begin with, the manned space flight program; this is how it was put by Aleksandr Ivanovich Dunayev, head of USSR Glavkosmos.

[Dunayev] This year we plan to stage three expeditions. We plan about five freighters to back up these expeditions, and we plan to launch a module. The Kristall module is what we call a technological module. That is the whole of the manned program. In principle, a sum—speaking from memory—of the order of 220 million rubles, has been allocated to this program.

[Zelentsov] I will add to this that one of our expeditions includes a Japanese cosmonaut with the launch on 2 December this year. The USSR Glavkosmos will receive 12 million for this flight. Apart from implementing manned flights, this year the program of launches of national economic satellites to order of the main administration for geodesy and cartography under the USSR Council of Ministers will be continued. These satellites will carry out photography of the earth's surface in the optical and infrared regions of the spectrum, carrying out tasks for more than 22 ministries and departments of our country. Part of this information will be sold abroad by the organization called Soyuzkarta. Incidentally, the demand for space photography is quite large because we sell these pictures more cheaply than other countries, and their resolution is higher than in any other country. For example, in the optical part of the spectrum, the resolution of our apparatus is five meters. That means that one can clearly identify on the photograph an object measuring five meters. There was a lot of interest in the report that preparations are under way to create a system for direct television broadcasting in our country. Nine relay satellites are planned for it. Incidentally, places have already been booked for them in geostationary orbit at a height of approximately 40,000 km above the earth. These satellites will relay television programs to the whole of the USSR's territory, to the countries of Eastern Europe, and to certain countries of the Far East and Southeast Asia. This is what Aleksandr Ivanovich Dunayev says about the state of affairs with the creation of this system.

[Dunayev] The system, we calculate, should consist of three of these Gals-type satellites, which will be three channel ones, and about five or six four-channel satellites of the Gelikon system. We are starting with the launch of the Gals because we think the oxygen-hydrogen booster will not be ready in our country in 1991 in order to lift the whole of the approximately 3.7 to 4 tonnes to geostationary orbit. We are currently carrying out urgent improvements on our existing booster in order to lift an extra 200 kilograms, so as to lift the three-channel Gals satellite. It will provide us, apart from the two all-union programs, with an opportunity for republican programs, and speaking from memory, it will provide a large number of radio programs, including stereophonic ones. Certain of our union republics have even expressed a wish to start helping in

implementing the finance for these programs. If such a possibility were examined, we would of course push ahead with this work, and indeed meet the date which we have taken upon ourselves for launching the first satellite in December 1990, because we do not see any serious technical problems in organizing it.

Minister Discusses Space Program in Cosmonautics Day Interview

907Q0076A Moscow TRUD in Russian 12 Apr 90 pp 1, 4

[Report on interview with USSR Minister of General Machine Building O.N. Shishkin by V. Golovachev, TRUD political columnist: "Plants Beyond Earth, Settlement on the Moon... USSR Minister of General Machine Building O.N. Shishkin Talks About the Development of Cosmonautics and Related Critical Problems"]

[Text] **Twenty-nine years ago today—12 April—Yuriy Gagarin completed a flight into outer space for the first time in the history of mankind. I remember very well the general rejoicing, the mass processions of singing and smiling people in the streets, and the homemade placards... But today the conquest of space evokes far less romantic enthusiasm, and people are more and more interested in the practical aspect: appropriations for space exploration and the benefits to be gained. And this, in general, is understandable. This is the kind of questions that readers ask in their letters: With 40 million people living on the edge of poverty in this country, is it appropriate to spend many billions for space? And, overall, where is cosmonautics going, and what are the objectives and priorities here?**

We turned with these and other questions to the USSR minister of general machine building, O.N. Shishkin. This is the minister's first interview. Until recently, the profile of the ministry was considered top secret: Enterprises of this branch produce the country's rocket equipment (both for the military and for space exploration). A very complicated electronic panel next to the minister's desk makes it possible to make instantaneous contact over special communications lines with any missile plant and other installations..

"Let us depart from the traditional victory celebration interview on the occasion of Cosmonautics Day," Oleg Nikolayevich proposed. "Ask the most pointed questions, and I will try to answer them. This will be more interesting and useful to the matter at hand."

Indeed, the beginning of the interview was unexpected and very promising...

[Golovachev] Well then, the most pointed question—about expend..ures and income. Will our cosmonautics ever pay for itself?

[Shishkin] It is known that basic research paves society's way to the future, that it can bring the most fantastic discoveries— including new technologies in which, according to the overall level of development of cosmonautics, we are today on a par with the United States (and not long ago we were behind)—that we occupy a leading position in the world, and that this priceless potential is very important for our economy. All of this is very real. But today, under conditions of a serious economic crisis, it is not strategy and not the prospects that trouble people, but purely pragmatic considerations: Will there be a profit from cosmonautics in the end? I do not want to criticize such a simplified approach, it is understandable in human terms, and, therefore, I will switch to the language of figures. The current space flight of Solovyev and Balandin will not only compensate for all current expenditures for this expedition, but it will also make a profit of R25 million (from the alloys, crystals, biological materials, unique medicines, photos of the earth's surface, information for fishermen, etc., obtained in outer space).

But if you take all of the expenditures on cosmonautics, then it will not be able to pay for itself this year. (Although, for example, each ruble invested in the creation of a Soviet system for optical-photographic observation from outer space already brings a profit of R8.) But in 1992 cosmonautics will have the kind of an economic effect that will not only fully cover all annual expenses but will also bring a profit. Thus, we are coming out onto a level of complete cost recovery. And this is without even taking into account the commercial projects of Glavkosmos [Main Administration for the Development and Use of Space Technology for the National Economy and Scientific Research].

[Golovachev] What projects do you have in mind? The sale of launch vehicles?

[Shishkin] Yes, that too. Today, for the time being, only our country offers the world market such a wide range of reliable launch vehicles: lift capabilities of 5, 7, 12, 10, and 100 tons. We are prepared for any forms of cooperation: building space vehicle launch facilities for a customer in any place he chooses, selling our launch vehicles, launching satellites and other objects of the customer from our space launch facilities, and organizing joint enterprises...

As is known, restrictions adopted by the United States currently hinder commercial activity that would be beneficial to each side. For example, the delivery of foreign satellites to our launch facilities is not allowed, if the satellites use new American equipment, even though we guarantee the inviolability of apparatus and even offer to allow foreign specialists to watch over them up to the very launch of the delivery vehicle.

[Golovachev] Perhaps a greater role is played here by commercial considerations and efforts not to permit competition than by questions of secrecy or political considerations?

[Shishkin] It is entirely possible. But third countries definitely lose out in this economic plan.

[Golovachev] And if, as some businessmen propose, space vehicle launching facilities are built in some third country?

[Shishkin] Yes, this is an interesting variant. And such negotiations currently are being conducted with Australia. The idea is simple: Build a space vehicle launching site in Australia according to our design and with our participation. But its operation, servicing, and all launches are conducted by the Australians. We only sell them our launch vehicles, but they themselves find customers, conclude contracts, conduct commercial activity, and so forth. The idea is alluring, and it has promise. And this was confirmed by both sides in the negotiations.

[Golovachev] Let us compare this class of launch vehicles that not only we but also other countries have. Whose vehicles are cheaper: ours or, let us say, the American vehicles?

[Shishkin] Ours, and by quite a bit. For example, a rocket of our "Proton" class and its launch costs $75 million in the United States; in our country it is many times cheaper. It was possible to achieve this because of technology, serial production, and a number of other factors, so that we are not afraid of competition, and here we hold strong positions.

[Golovachev] But one also has to know how to do business...

[Shishkin] Here you hit the nail on the head, and this is our weak spot. We still have not mastered the art and science of commerce. This is a very difficult matter, but we do not have either the experience or the tradition. We have to learn by doing.

[Golovachev] Nonetheless, something is being done here. For example, English journals reported on negotiations between Glavkosmos and British firms concerning the sale of satellite information receiving stations. Other publications talk about the fact that Glavkosmos is offering Soviet satellite communications channels of the "Gorizont" type.

[Shishkin] Yes, this is true. With the help of Soviet stations, British firms would be able to take and sell (on contract with us, of course) various information that is received from on board Soviet satellites. Requirements for photos of one or another area would have to be submitted by customers not less than two days before. Control of the vehicles will remain with the Soviet Union. I want to note an important detail that many Western specialists emphasize: In Soviet space photos, objects can be distinguished that have dimensions of five to 10 meters, and the resolution capability of the equipment of the American "Landsat" satellites is 30 meters, and of the French "Spot" satellites, 10-12 meters.

Great possibilities are also being opened up by the use of communications channels of our current and prospective outer space apparatuses: for example, the future Soviet direct television relay satellite "Gelikon" (launch is planned for next year).

There are also commercial contracts with a West German firm, in addition to other foreign partners.

[Golovachev] It is said that we also sold the "Mir" station scale model—an analog that remained on earth. Is that true?

[Shishkin] But what is special here? We will not need this station anymore in the future. A Japanese firm bought it. Foreign specialists engaged in the exploration of outer space will study the station with great interest. In any case, the sale of a large-scale model of the "Mir" station is a symbol of the development of international cooperation and will contribute to the idea of cooperation in the field of space research between the USSR and Japan.

[Golovachev] The question of broad international cooperation in the exploration of outer space today is especially urgent. What are the prospects here?

[Shishkin] Historically, it turned out that cosmonautics developed under conditions of the opposition of two great powers. And the concept was built on this: Peace could be preserved only through opposition, by increasing the nuclear missile potential. The whole country gave the best that it had to assure parity.

Rivalry clearly manifested itself in space research as well. Prestige considerations demanded getting ahead of the Americans here and there, and wherever it was possible; and, at the same time, the same tasks were placed before the Americans. But one asks: Why under conditions of peaceful coexistence and the development of cooperation should each country go its own way, developing one and the same design and resolving one and the same task in parallel? More and more countries are now joining in the exploration of outer space. Must they also repeat this path, expending gigantic resources? Is it not more advisable to cooperate, to divide the tasks, and, afterwards, to exchange the obtained results? The benefit of this to humanity is apparent. And, today, in the epoch of the new political thinking, such collaboration and cooperation can, in my opinion, become a reality. This can be advantageous to everyone, including the United States. Because in a number of positions, we are surpassing America—this is the unique experience of long flights, the development of designs of orbital stations (which specialists from the United States who visited us recently became convinced of), and so forth. But the main thing is that it is necessary to eliminate duplication, which will give a tremendous economy of resources. For example, we could participate in the establishment of a lunar settlement, which is necessary for the further exploration of outer space (this task is being discussed in the United States, Japan, and in a number of other countries).

We and NASA are now readying important proposals on collaboration and cooperation. It is entirely possible that this will become a subject of discussions during the forthcoming meeting between USSR President M.S. Gorbachev and U.S. President G. Bush.

[Golovachev] One immediately desires to pose a specific question. Work is being done both here and in the United States on the development of large (on the order of 100 meters) orbital stations. The cost of each is measured in many billions of rubles and dollars. Are you prepared to consider the question of the development of a joint large station?

[Shishkin] The question, I will say frankly, is unexpected. You see, these stations have to service satellites, including military satellites as well. Well then, I do not know about the American side, but I would be ready to discuss this question, although it seems fantastic today.

[Golovachev] Since we are discussing stations of the next generation, could you not talk a little about "Mir-2"?

[Shishkin] This station, whose launch, I think, will be feasible in the years 1997-1998, should be working in the next century. For the time being, "Mir-2" is visualized as a large composite construction with many docking ports. Communications, weather, ecological, and observation satellites could be delivered here for repair (which is much cheaper than conducting new launches); and various research modules and outer space plants for the production of unique medicines, alloys, crystals, etc. will be docked at the ports.

Very strict demands are being made on the design. For example, a 100-meter truss can have a warp at the ends of only several millimeters. This is in space flight, and under the impact, figuratively speaking, of from 100 degrees of heat to 100 degrees of cold. Not very long ago this seemed unachievable...

Our scientists successfully resolved the problems of welding such designs in outer space. Incidentally, such experiments were conducted by Savitskaya during her space flight.

Well, it is too early to speak more specifically about the station, because a lot depends on those orders and contracts that will be concluded on a commercial basis and on the appropriations the USSR Supreme Soviet will allocate.

[Golovachev] Here we are coming to the question of a program for exploiting outer space. This is the opinion of General V. Shatalov: "Cosmonautics does not have a real 'boss'. The main efforts of the originators of outer space equipment are directed at endlessly perfecting the equipment. The USSR Academy of Sciences and other departments are not showing concern about its payoff..." Is it not time that we set up an organ like NASA in the United States?

[Shishkin] This question requires additional discussion. But it is clear that not everything here in our country is all right. At least I am firmly convinced that customers should not be individual scientists and academicians (as is frequently the case now), but an independent organization. And, of course, not our ministry.

[Golovachev] I want to quote General V. Shatalov once more. He ascertains bitterly that "many of the instruments on the station are 'unfinished,' that half of the scientific equipment does not work. The crews spend a lot of time on technical repair work." This really is wasteful. A serious charge against your department.

[Shishkin] What can I say? Criticism has to be answered with action. The question was put properly. And we are now undertaking serious measures to correct the situation.

[Golovachev] You are not offended by criticism?

[Shishkin] I think that we are still not being criticized a lot.

[Golovachev] Well, then, here is this question. Academician V.P. Mishin (in the past, the deputy of S.P. Korolev, and after his death, the chief designer) and a number of other specialists believe that the development in our country of the "Energiya-Buran" system marked a repetition of all of the American mistakes, but in an even more serious form. The employment of a reusable spacecraft is much more expensive than one-time launches. The development of the "shuttle" was a mistake and a miscalculation by the Americans, and we repeated this mistake. The time has not come for "Buran," and we do not need it... What is your opinion?

[Shishkin] Perhaps you will be surprised, but when the question of the development of "Buran" was being discussed, I was against it. But afterwards—that is the way it turned out—it was I in the ministry who answered for the development of a reusable spacecraft. Today, analyzing the situation, I must admit that I was not right when I objected to "Buran." And the birth of the "shuttle" was not a mistake, and our reusable spacecraft in the near future will find application in the return of valuable cargoes from outer space to earth and in servicing orbiting complexes, outer space plants, etc. I am not even talking about the fact that in the process of work on the "Energiya" rocket and the "Buran" reusable spacecraft, new technologies, technical innovations, and a modern scientific-production infrastructure were established, that is, that work which was already done that assures the development of branches and industries on the whole for many years into the future.

In addition, in contrast to the Americans, we are able to insert into orbit large (up to 100 tons or more) payloads at the price of an expendable rocket. And this is several times cheaper.

[Golovachev] When will the next flight of "Buran" be?

[Shishkin] In 1991. The second copy of the reusable spacecraft, which is now being tested at Baykonur, will be sent on an unmanned trip. "Buran" will dock with

"Mir," more correctly with the "Kristal" module, which will have been launched to the orbital complex. The cosmonauts will move into the reusable spacecraft, they will work in it, and they will conduct tests with the manipulator. Later, in an unmanned mode, "Buran" will move away from "Mir ' and the next stage of tests will begin. The "Soyuz" spacecraft, with a crew on board, will dock at the reusable spacecraft. A joint flight will be executec after which "Buran" will return to earth and the crew of the "Soyuz" will depart for "Mir"... So "Buran" will not be flying in an unmanned mode all of the time.

[Golovachev] Is the question of the future development of an aerospace plane, which can fly from Moscow to New York in one and a half hours being studied in our country?

[Shishkin] This is an interesting question. Yes, research is being conducted now on possible variants of aerospace aircraft. For the time being, this is work of a general nature, concept definition. A search is going on for an aircraft configuration and the most efficient areas for its application are being studied. A very important point lies ahead: to select the principal variant. Incidentally, the development of "Buran" is a very important and necessary step on the way to an aerospace plane. As for actual flights, I think they will begin in the next century.

[Golovachev] And the last question—about conversion. It is known that its scale in your branch is great. For example, all kinds of modern equipment for the agro-industrial complex will be developed in plants of the Ministry of General Machine Building. But I ask you to talk about only one "narrow" and extremely important sphere: manufacturing prosthetic appliances and medical equipment.

[Shishkin] I do not know what can be more grave on a moral plane than the state of prosthetic appliance manufacture in our country. I was really embarrassed when I became familiar with the production of prosthetic appliances. How can a society consider itself humane which treats its invalids this way? Imagine: A shop with a dirt floor (this is in our day!), and only linden wood, aluminum, and straps are used for the manufacture of prosthetic appliances. The stone age - it is simply a disgrace...

We began to work on the problem immediately. Already 20,000 prosthetic appliances of a modern standard—as good as in the FRG— will be manufactured this year. A Soviet invalid child was sent to the United States to a competition, and she got through 42 km...

We will continue to raise the production of these prosthetic devices until the middle of 1992, and then we will shift to the production of bio-prosthetic appliances. They will operate on the biocurrents of remaining muscles or even on biocurrents of the brain. Everyone is treating the fulfillment of these tasks with great attention, which is our sacred duty to the invalids. And, in conclusion, about a very serious problem: the production of disposable syringes. This year our ministry alone produced 250 million of them and about a billion needles. Next year—a billion syringes and 3 billion needles. I believe the problem will be resolved very soon.

TV Commentary on Cosmonautics Day

LD1204224990 Moscow Television Service in Russian 1700 GMT 12 Apr 90

[From the "Vremya" newscast; video report by S. Slipchenko]

[Text] Today is Cosmonautics Day—a fine and glorious festival in honor of our triumphs. But nowadays we mark even such triumphal dates by recalling more than just the achievements and successes.

[Slipchenko] One might now call Soviet cosmonautics 30 years of discoveries and untapped possibilities. The secret doors are opening with tortuous slowness and we discover that the Kompozit scientific production association long ago created unique materials and technology without parallel in the world, and that the machines in which they are used are being purchased both by Japan and the United States—to whom we now so often turn. [video shows archive footage of a rocket launch, followed by pictures of a display of materials]

This here is the plant of the Metalworking and Machine-Building Research Institute [Niimetmash], which created an aerial for the Aktivnyy international space project. This experience of course enhanced the quality of developments for heavy industry throughout the country. [video shows close up of work produced at the institute]

The Energiya scientific production association has been developing plans for a heavy space platform to solve communications problems. [video shows wall diagrams portraying platform]

This is another project for a system of communications that is being developed by two purely space firms—the Astra scientific production association and the Prikladnaya Mekhanika [applied mechanics] scientific production association. Formerly, it must be owned, they were fulfilling orders for the Defense Ministry. Now they are counting on covering the country with communications lines in the years 1992-93 by means of space facilities that already exist. After all, there is only an average of one and a half telephones for 10,000-15,000 people in most of the country's territory. [video shows wall diagram of Marafon [Marathon] satellite communications system network using mobile and remote installations]

You are now seeing fragments from material that has not previously been broadcast. Do we know much about space projects? Do we know that 20 years ago Soviet man was due to land on the moon and the technology had been created. Here are the remains of a rocket that came down during a test. The project was closed down and the

achievements were kept secret. This means that progress too was halted. [video shows debris of rocket scattered over terrain]

This is the story not only of cosmonautics but indeed of our country. A single droplet of water is salty just as the whole sea is. Similarly the droplet of cosmonautics is now, as it were, made up of contradictions—just as the whole sea of our economy and industry is. This sector is urgently making medical equipment, but the Institute of Medicobiological Problems has insufficient funds for science and for new equipment. Money has been allocated for scientific research under the Mars-94 international project, while there is no money for the creation of the apparatus in which science must fly. [video shows various types of medical equipment]

How then is one to mark Cosmonautics Day? It seems to me that one should bow low to Anatoliy Solovev and Aleksandr Balandin who are now working in orbit and to all the people in this vast sector who have made our country a power, and which alone is referred to throughout the world as the jewel in the crown of Soviet industry. [video shows Solovev and Balandin in orbit; and booster on launch pad]

TV Program Reviews Space Accomplishments, Failures

LD1504111890

[Editorial Report] Moscow Television Service in Russian at 1310 GMT on 12 April carries a 60-minute "Special Cosmonautics Day" edition of the "Man, Earth, Universe" program, presented by Vitaliy Sevastyanov. Sevastyanov, in a communications session recorded at Flight Control Center on 4 April, participates in a hookup with orbiting cosmonauts Balandin and Solovyev, who describe their memories and impressions of Gagarin, the first cosmonaut. The cosmonauts are shown taking a spectrographic readout of a point on earth using (?Gemma) equipment. A viewer has asked for a reading of the atmosphere of Nizhniy-Tagil to be taken, but for technical reasons this is said to be impossible. Writer Yaroslav Golovanov then gives biographical sketches of rocket designer Korolev and his assistants and colleagues.

Academician Barmin describes Soviet efforts in the moon race of the 1960's and the disappointment over the fact that Khrushchev failed to come up with the necessary funding, thus allowing the Americans to get there first. Old mock-ups and models of proposed lunar stations and moon accommodations are shown from projects that were ultimately deemed too expensive to realize in this century. Experiments in which men spent up to 12 months in sealed chambers on earth, using regenerated air and water, are described.

A film, stated in a caption to have been shot by the USSR Ministry of Defense film studios, then shows Baykonyr in Kazakhstan, which "in the middle of the century" was picked for the realization of "mankind's audacious dream." The launch complex and measuring complex are located "tens of kilometers" from each other. "Hundreds of kilometers" of pipes and cables have been laid, and the huge facility is linked by rail and road. The cosmodrome's "birthday" was 2 June 1955. When the first rockets were being launched to Kamchatka, people were already "dreaming of the stars" and the builders called the town "Zvezdograd." "In the summer, it is 45 degrees in the shade, and the burning wind carries a sand as fine as dust. But in recent years, confirming the fears of scientists, the wind increasingly brings with it a bitter, salty dust from the Aral Sea, which is drying up. This did not use to happen." The commentary describes the memory of triumphs, as well as "bitter and difficult days for Baykonyr and the whole country, when the usual seeing-off ceremonies into a space that already seemed homely and close were not followed by joyful welcomes." "Veterans remember rockets burning up during tests, and test workers failing to return from their daily work." This passage is accompanied by black-and-white footage of an intense fire at what appears to be a launch site. Figures can be seen running toward the camera and away from the conflagration. The figures are on fire. The number of rockets prepared for launch at Baykonyr numbered "thousands," the commentary says. The video shows archive film of early years at Baykonyr; trains in the desert; camels looking at a launch site; people exercising, celebrating; more modern shots of rockets going up and shots of the launch site, including a Buran in a hangar.

Mars-94 Mission Financial Difficulties

LD1304030190 Moscow TASS International Service in Russian 1804 GMT 12 Apr 90

[Text] Moscow, 12 Apr (TASS)—"The present level of our knowledge now makes it possible to discover new 'secrets' about Mars. The main aim of the planned 'Mars-94' project is to carry out a detailed collection of data about the planet prior to its actual exploration, which will probably take place soon." This opinion was expressed at a press conference held here today by Albert Galeyev, director of the Institute of Space Research of the USSR Academy of Science, the principal organization involved in the implementaion of the national "Mars" program.

The press conference was attended by representatives of the National Aeronautic and Space Administration, NASA, and by specialists from the Jet Propulsion Laboratory at Pasadena in the United States, from the French National Center for Space Research, and other scientific organizations. Altogether, 21 countries are taking part in the preparations for the "Mars-94" project.

The Soviet specialist recalled that the project envisages the launch in 1994 of two spacecraft equipped with up-to-date scientific apparatus. They will put two satellites into orbit around Mars. The satellites will transmit back to earth data about the surface of this planet, its

ionosphere and the plasma surrounding it. Furthermore, two air balloons will be detached from the spacecraft to study the meteorological conditions of the planet.

Referring to the problems of financing the project, Albert Galeyev noted that the USSR State Committee for Science and Technology allocated for this year the necessary funds for the development of the scientific equipment, i.e. R20 million. However, the question of financing the manufacture of the spacecraft and booster rockets, for which the Ministry of General Machine-Building is responsible, has still not been resolved. Our internal financial difficulties, Albert Galeyev said, could have a negative effect on the implementation of the international project as a whole. All in all, the scientist said the implementation of the project requires about R500 million.

After the success of the United States's Viking-1 and Viking-2 Mars projects, during which a great deal of scientific data was obtained, Albert Galeyev noted, we hesitated for a long time before deciding to go ahead with a new and more detailed study of the planet. However, it might cost mankind consderably more to go on deferring important research for years and decades.

Commentaries on N-1 Booster and Manned Lunar Mission Program

907Q0043 Moscow KRASNAYA ZVEZDA in Russian 13 Jan 90 1st ed p 4

[Article by Col. M. Rebrov, "Krasnaya Zvezda" special correspondent, with commentaries by Georgiy Stepanovich Vetrov, doctor of technical sciences and scientific associate in the Special Design Bureau imeni S. P. Korolev; Professor Yuriy Aleksandrovich Mozzhorin, director of the Central Scientific Research Institute of Machine Building, doctor of technical sciences, Hero of Socialist Labor; and Vladimir Vasilyevich Vakhnichenko, candidate of technical sciences: "But Things Were Like That—Top Secret: The Painful Fortune of the N-1 Project"]

[Text] The triumph of the Apollo project and the American landing on the surface of the Moon were not perceived as a supersensation. Things had been leading up to that. The stages on the long and difficult path, the successes and the disappointments, the risky tests and the dangerous malfunctions, were all reported in detail, openly and without bias. But nevertheless, when the ether brought a human voice from another celestial body back to Earth, the planet reacted to it rapidly and with enthusiasm. And what about us, the ones who had initiated the bold storming of space, who had launched the first satellites, who were the first to "make it" to the mysterious Moon with our lunar rockets, who had shook the world with the flight of Yuriy Gagarin? How could it happen that in a single hour we had suddenly become second?

Up to a time—more precisely, right up to that event—we thought we would maintain leadership in space forever. "They" were sure to fail in some way, we reassured ourselves, looking skeptically on their predictions. Complacency turned into a "loss of tempo"...and of prestige.

My work as a journalist brought me into contact with many of those who were developing rocket-space technology, some who were setting up our space programs, others who were training space crews. All kinds of things happened: there were confidential conversations, there were extremely barren opinions expressed that knew nothing about what was happening and explained nothing, and there was the irritated "We can't talk about that yet." At times, more precise questioning met with incomprehension and even fright. For a long time, everything that had anything to do with space was hidden under the stamp "Top Secret."

Meanwhile, the questions remained. The vacuum of reliable information was filled by rumors, fabrications and conjectures. The truth was distorted. One and the same fact would acquire a great many "hues," and the truth lay buried somewhere beneath the ambiguous statements someone had contrived.

I do not at all intend to force upon the reader the notion that everything which is related below is the final truth of the matter. Space programs and design and engineering concepts and solutions represent creativity. "It is akin to art, it has its own soul, its own wings" (those are the words of S. P. Korolev), and so it's hard to expect an identical perception of events by all those who, to one degree or other, took part in them.

Nevertheless, just what has time revealed?

After the launching of our satellite and Gagarin's flight, America was in shock. "Space revenge" was demanded of the president. A program for landing Americans on the Moon was quickly drawn up. It was declared a high national priority, and Congress voted to allocate billions in subsidies in order to raise America's prestige. The time was May 1961.

However, engineering sketches and calculations for a flight to the Moon (not just the idea, but the designer's concept and the technical development work) had appeared much earlier. Not in America, but here in our country. It would be naive to support that with references to Tsiolkovskiy or by citing the positive arguments of Tsander or the works of Kondratyuk. There exists a verbatim account of a report by S. P. Korolev at the USSR Academy of Sciences presented in 1956.

"The development of rocket flight to the Moon and back," said Sergey Pavlovich, "is a practicable task. The job can be done most simply with a launch from a satellite, but it also can be done with a launch from the Earth. Somewhat more difficult is the return to the Earth of a vehicle mounted on a satellite or on a rocket launched to the Moon. But it must not be thought that the proposals I have made are very far off..."

In late 1957, Korolev expressed himself more definitely: "The task of reaching the Moon is technically feasible at the present time..." Early in 1958 he laid out a detailed plan for lunar exploration, with a list of the technical problems that had to be solved in the process, plus possible variations for their solution.

I could cite more than a few documents that would make it possible to trace the chronicle of our lunar project, which has gone down into history as the "N-1" project. By the way, that was the name of the launch vehicle. As for the spacecraft it was to deliver into a given region of space, they had their own designations: L-1 for the craft that would fly around the Moon and return to the Earth, L-3 for the craft that would land cosmonauts onto the lunar surface. The living testimony of those who were associated in one way or other with those projects makes it possible, in my opinion, to feel more keenly the times, and the events, and the lives of the people.

Georgiy Stepanovich Vetrov, doctor of technical sciences, scientific associate in the Special Design Bureau imeni S. P. Korolev:

"The development of the N-1 launch vehicle was an outstanding achievement of the group headed by Sergey Pavlovich Korolev and of the organizations that participated in the project. Quite unusual and vast. Today it's history, but looking back, it is important to draw lessons from it and to do justice to the team of Korolev's OKB [special design bureau]. The secrecy in which, until recently, the N-1 was shrouded fed all kinds of concoctions and subjective evaluations...

"A characteristic trait of Korolev the designer was his ability to look far ahead. The first concepts for heavy launch vehicles appeared in 1956, prior to the first flight of the R-7 intercontinental missile. They were discussed at the Council of Chief Designers and at the governmental level in July 1957. At the time, the idea of creating a heavy launch vehicle was deemed premature. But as early as in 1960, at Sergey Pavlovich's initiative, a decree was adopted on preliminary studies for a heavy launch vehicle, and in 1962, a decree on the working up of a draft plan [R. eskiznyy proyekt] for a new rocket, which was assigned the designation N-1.

"In working on the project, Korolev understood this—that the so-called 'bundle' configuration was unsuitable for a heavy launch vehicle. Then the idea was born of constructing a rocket with a single-unit configuration with spherical, large-diameter tanks. That was a science-fiction design in those days. A serious problem arose in the transportation of the units from the manufacturing plant to Baykonur. Just imagine—the maximum diameter of the lower stage was 17 meters. It was impossible to transport a load of such a size by railroad. So what to do?...

"Let me explain what happened. Several transportation schemes were played with: a special giant aircraft, a dirigible, construction of a canal from the Caspian to the Baykonur region, the construction of a special highway, the transfer of factory workshops to the cosmodrome, and the construction of a new cosmodrome. No, people weren't just throwing around wild schemes. Everything was considered through and through in the search for the best choice. Finally, a solution was found. The design, as it was devised, was efficient, and the assembly was done in the MIK [assembly-and-testing building], at Baykonur.

"The powerful launcher was to be used in the future for a manned expedition to Mars. The project also looked at the possibility of using nuclear electric rocket and hydrogen engines. The N-1 design incorporated variations of the use of the upper stages as independent launch vehicles for delivering various cargoes into space.

"The draft plan was adopted by the expert commission and was recommended for development. The flight tests, which began in February 1972, confirmed the correctness of the designs and the production and operational characteristics chosen for the rocket. Unfortunately, not one of the four launches was successful. On 15 May 1974, work on the N-1 was suspended, and in March 1976 it was terminated...

"The painful fortune of the N-1 is explained in a lot of ways. In my opinion, one of the factors that prevented such a vast project from getting done was the dissipation of personnel and financial resources. The project had long been adopted for further development when a great deal of money was diverted for the establishment of still another special design bureau. It was headed by V. N. Chelomey, who enjoyed a special relationship with N. S. Khrushchev. During that time, the furtherance of the project required the cooperation of three special design bureaus—those headed by S. P. Korolev, M. K. Yangel and V. N. Chelomey—a cooperation that Sergey Pavlovich pressed for. But at that time, Chelomey began to design his UR-700 rocket based on the Glushko engines. Such fragmentation naturally slowed the work on the N-1."

"Let me cite the opinion of one space program organizer, Professor G. N. Pashkov, doctor of technical sciences: "At that time, a decision was made that, in actuality, shifted the 'firms' of S. P. Korolev and M. K. Yangel from primary roles to secondary roles... A project appeared which was given preference over all the others... I was startled that the designer was attempting to complete the entire project in only three years. Naturally, on the orders of N. S. Khrushchev, he was immediately allocated the funds, and large programs in which major work had already been started were stripped. Korolev didn't get the necessary resources..."

"Specialists of the Korolev special design bureau wrote a memorandum to the Minister S. A. Afanasyev. After a clash of opinions, the UR-700 was finally "axed," but time had been lost.

"Among the responsible factors I would also mention the monopoly of the V. P. Glushko special design bureau

with respect to the development of liquid-fuel rocket engines, which hindered Korolev in attracting other design teams to his work.

"Valentin Petrovich saw promise for the development of powerful rocket engines in the use of synthetic fuel, which initially was to be used for the N-1 together with oxygen as the oxidizer. When it became clear that it would be virtually impossible to create an engine with such components, Korolev was faced with a difficult choice. Glushko insisted that the N-1 use a liquid-fuel rocket engine based on components that worsened considerably the technical-flight characteristics of the rocket, sharply increased the cost of launches, and were difficult to use because of high toxicity. At that point, Korolev could count only on N. D. Kuznetsov, although Nikolay Dmitriyevich's primary specialization was aviation engines."

"Kuznetsov did not have the necessary facilities or test stands. This would result in great losses of time. Korolev wrote 'stern' letters to Kuznetsov and simultaneously appealed to the then-secretary of the oblast committee, V. I. Vorotnikov, to help Nikolay Dmitriyevich. A third letter immediately went to V. E. Dymshits of the Council of Ministers: 'The people in Kuybyshev are having a hard time. Help them!' That's how Sergey Pavlovich strove to 'press all the buttons.'

"Later, by the way, when Glushko was the General Designer of the Energiya launch vehicle, he scrapped the fuel components which he had proposed for the N-1 and returned to the fuel which Korolev had insisted on.

"After Sergey Pavlovich died, his successor was Academician V. P. Mishin, who assumed the responsibility for handling the fundamental difficulties in completing the work on the project. The high level of professionalism of the Korolev team guaranteed success, but the natural course of events was disrupted by the decision disappointing to the team to curtail work on the project..."

Professor Yuriy Aleksandrovich Mozzhorin, Hero of Socialist Labor, doctor of technical sciences, director TsNIIMash [Central Scientific Research Institute of Machine Building]:

"I became acquainted with Vasiliy Pavlovich Mishin when I began work with Chief Designer V. F. Bolkhovitinov. That was in 1940. We worked in the evenings, and I studied as a third-year student at MATI [Moscow Aviation Technological Institute] during the day. At the beginning of the war I went as a volunteer to the front. We met each other again in Germany: I, a senior lieutenant, and he a lieutenant colonel.

"Secrecy about space? Yes, there was. Why, for what reason? In those years there was a competition with America in many technical fields. The Americans pompously declared that they would be the first to launch an earth satellite and showered praise on themselves, haughtily assuming that they had no competitors. During that period, the 'cold war' was growing stronger, and that also left its mark on the times.

"Korolev reasoned this way: the American Vanguard rocket was too 'weak' to use for performing serious space experiments. The Americans were boasting more than anything else, but we had a launcher that could put a large, heavy satellite into space. We decided to race ahead of them since we had the opportunity, but we didn't advertize our intentions. There was no reason to!

"Initially, we were preparing a heavy, complex satellite. But events were developing in such a way that the Americans could beat us to the punch. Then the PS [Russian initials for *very simple satellite*) project made its appearance. But even it, in many respects, surpassed that devised by the Americans. The launch of our 'first' rocked the world.

"Then came Layka. And it was also a success. There was enthusiasm, daring plans. It was decided to send a rocket to the Moon. The first was wide of the mark, but it was nevertheless a success. The second rocket delivered a pennant to the lunar surface. But we were looking farther, and we were thinking about interplanetary flights to Venus and Mars. And we weren't just thinking about it, we were developing such projects. In short, there were many programs, and all of them were feasible.

"The Americans began to make preparations for manned flight into space. First—a vertical launch to a great altitude... The Mercury ship was made small and light, because they had no heavy-lift vehicle.

"The R-7—'No 7'—could be used to solve problems of a more complex nature. That's what gave Korolev the idea of flying a man around the Earth. Work began on the Vostok. At that time, it was called the 'little sphere.' The craft was tested in unmanned flights, and then with small dogs and a mannequin. And again, everything was done without broad publicity, but it was done thoroughly and with great enthusiasm. We wanted to be the first. All the more so because we could be. In fact, we conceived all this much earlier than did the Americans."

"The enthusiasm for the preparations for the first manned flight can easily be seen from the following example. Once, a failed orbital injection carried the 'little sphere' with a small dog in it into the region of the Tunguska meteorite to the Podkamennaya Tunguska River. Its fate was predetermined for the craft carried 10 kg of TNT, and there was a special detonation system for use in the case of unscheduled entry into the atmosphere. Even if this system were not triggered, a clock mechanism would detonate the 'little sphere' after 60 hours. Secrecy was also maintained on this point.

"So this is what happened: not 10 minutes had passed when we received the coded message: 'We have a bearing on your sphere on the ground.' 'How can that be?'—there was perplexity. 'It didn't blow up?' Confirmation was received: 'The bearing was also along the flight trajectory.'

"An expedition of 14 men immediately flew from Baykonur in order to rescue the small dog. The flight was via Krasnoyarsk. The weather was no good, there was fog, and they wouldn't clear the aircraft for takeoff. The military commandant did not want to assume the responsibility. They flew out without permission. Two developers of the detonation system were called from Leningrad, and other specialists were flown from Kuybyshev; they were roused in the middle of the night and flown to Krasoyarsk. From there they arrived on the scene not without adventures. And what did they find? The dog had actually survived. The cable in the detonation device had burned through and shorted the circuit.

"Gagarin's launch! A triumph. The planet is exultant. Then Titov's day-long flight, the group flight, the multiday flight, the first woman cosmonaut, the multi-crew spacecraft, the EVA... We had unquestioned leadership in manned and unmanned craft. By the early 1960's research work was already being done on the development of the Proton rocket (today it is used for putting the 'Kvants' and Mir into orbit), and a project was being studied for a superheavy-lift launch vehicle based on oxygen and kerosene. When the United States announced its lunar program, we weighed our possibilities and decided that we would not yield our supremacy here. The task was relatively simple and not so expensive.

"Korolev proposed the N-1 booster project. After its capabilities were evaluated, it was clear that vehicle's payload would have to be 'jacked up' to 90 tons. It turned out that such a rocket would require 24 engines, each with a thrust of 150 tons, on the first stage. However, further computations indicated that those 90 tons wouldn't suffice: at least 95 tons was needed. The number of engines was increased to 30, but 'a little bit more' was needed to provide enough power. And at that point, a solution was found: fueling with supercooled oxygen and kerosene made it possible to take more fuel aboard.

"The configuration turned out to be complex. Three stages were required for the exit to a reference near-Earth orbit. Then the boost stage is fired—the 'G' block—which would put the ship on a lunar trajectory. There the braking 'D' block would be fired, and the ship would enter a lunar orbit. The 'Ye' block would be used for landing a capsule with one cosmonaut; a second cosmonaut would remain in the lunar orbiter ship (LOK). The program on the surface of the Moon was to last three days. Then there would be the lift-off from the Moon, docking with the LOK, transfer, boost, flight to the Earth, and braking in the atmosphere. A system of seven phases was devised.

"A problem arose with the engines from the very beginning of implementation of the project. Which fuel components would be used? Glushko made a 150-ton nitrogen tetroxide engine for the Proton and proposed his engine with a thrust of 600 tons for the N-1 using these same components. Korolev felt that an engine operating on liquid oxygen was required. He understood that 1,500 tons of the 'nitrogen mixture' would be very dangerous in the event of an accident; it would be like a powerful poison gas attack.

"Glushko did not want to yield. Korolev insisted. The commission convened under the chairmanship of M. V. Keldysh and came out in favor of the oxygen. Glushko refused to participate in the project. Then Korolev turned to Kuznetsov. Nikolay Dmitriyevich tackled the construction of the 150-ton engine. And he did it. But it 'suffered all the diseases' associated with a new line of work. And that, naturally, affected the timetable...

"First it was felt that a linkup of 30 engines was good because the reliability of such a large linkup could be methodically increases by in-flight shutdown of defective engines. In such a case, a normally operating, symmetrically positioned engine also would be shut off. However, that worked smoothly only on paper. Experiments showed that the 'Kord' emergency shutdown system was not able to diagnose an 'ailing' engine and shut it down. The engine would explode. And that meant that the collapse of the idea of ensuring reliability of a multiengine linkup."

"Work on the N-1 project in 1964-1966 was carried out under difficult conditions. Production capacities were inadequate: plans called for the fabrication of four N-1 rockets in a year's time, but only one and a half were constructed. There were delays in the timetable. Delivery of completed units was stalled. There were difficulties in solving the problem of constructing the necessary stands and experimental installations. The chief designers allowed serious deviations from the requirements for the final ground tests: 'Too long and costly,' they said. 'We'll debug it in flight.'

"Tests revealed a number of alarming points. And already it was October 1966, and the timeframe for the landing of the first Soviet cosmonaut on the Moon had already been approved: the third quarter of 1968. It was clear to me that the objective was becoming unrealistic and that the volume of the work ahead exceeded the capacities of the sector by a factor of 2-2.5. At a conference of the chief designers and curators, I expressed my doubts. They were met with criticism. Korolev's deputy for design, Sergey Osipovich Okhapkin (Mishin was on vacation) declared to D. F. Ustinov: 'We want to solve this problem, we can solve it, and we will solve it on schedule if we receive assistance.'

"In February 1967, the government signed a resolution calling for a speed-up of the work on the N-1 and L-3. However, the material-technical support needed for the projects was not available. Schedules were shifted. Stands were not being built in the necessary numbers. It was proposed that we could get by with the old method: working out the bugs during the experimental launches. But that was effective only when the objects being tested were simple and cheap. In this case, however, it was a

mistake. The Americans had spent $15 billion on the creation of an experimental base; we had spent only about $1 billion.

"The flight tests of the N-1 rocket began in full combination with the lunar and landing modules. The first launch was on 21 February 1969. Everything was going as planned. But at 70 seconds, there was a fire and an explosion. Mishin reassured everyone: 'This is normal for a first launch.'

"The second launch was on 3 July 1970. The launch vehicle lifted off from the pad and rose 100 meters in just a few seconds, and then an engine exploded. The 'Kord' system cut off all the engines, and the launch vehicle fell to the ground, destroying the launch complex.

"What now? Provision was made for 'loading' the rocket for pitch at the very beginning of the flight in order to protect the launch complex in the event of another such failure.

"On 27 July 1971—the third attempt. We had start. Liftoff. A rotation around the longitudinal axis began. After seven seconds, when the angle of rotation had reached 10 degrees, the automatic system shut the engines down.

"The fourth launch was on 28 December 1972. Ten seconds before the first stage was to shut down, longitudinal oscillations began, with an increasing amplitude. Then the destruction of the structure and an explosion...

"It must be said that a manned flight around the Moon had been visualized as one of the stages in the implementation of the N-1 programs. Seven Soyuz craft were prepared for the final tests of the craft's control system during entry into the dense layers of the atmosphere at a velocity close to Earth escape velocity. At that time, they were called Zonds. The skip-glide reentry technique was being perfected. The Proton booster and the D block of the L-3 craft were used for this purpose. Plans called for a landing in Kazakhstan. Two launches had been done with a splashdown in the Indian Ocean. They were successful. A tortoise had been secretly placed aboard one of the Zonds. It returned alive.

"By the 50th anniversary of the October Revolution, in 1967, we were about to make a manned flight around the Moon. But the Americans did it first. It made no sense to duplicate the feat..."

"Simultaneously with work on projects N-1 and L-3, an unmanned vehicle was being developed to bring back soil samples from the Moon. There was enough power for this. Georgiy Nikolayevich Babakin developed the landing-ascent stage. The launch of Luna-15 virtually coincided in time with the Apollo-11 expedition. The Americans issued a protest: they said that there was a danger of collision in a lunar orbit. We had calculated everything, and replied: 'We guarantee there won't be a problem.' If the launch had been successful, we would have brought lunar soil back to the Earth three days earlier than the Americans. But back then, we still knew little about the lunar gravity field, and during the landing the vehicle hit a mountain...

"One can legitimately ask the question, 'Why were the N-1 and L-3 projects closed down, and why did work on a superpowerful launch vehicle cease? There are several reasons. First, after four unsuccessful launches it became clear that to land a man safely on the Moon would require that we go through a long and painstaking process of working the bugs out of the launch vehicle and all the elements of the expeditionary complex. The costs were estimated at more than 10 billion rubles. Second, the delivery to Earth of lunar soil by Soviet automatic vehicles and American manned craft almost completely devalued the scientific significance of the expedition were were contemplating.

"However, in giving up flight to the Moon, it would seem, it didn't make any sense to stop work on the superpowerful launcher, especially since the course of development of space technology pointed to the future need for a rocket of such size. I was a supporter of continuing the development of the N-1, and at a meeting with D. F. Ustinov I spoke out in its defense, but I was unable to convince him....

"And what has time revealed? In answering that question from the present-day vantage point, it can be said that the decision to shut down the N-1 project was correct. At that time—and indeed even now—there were no specific payloads for the N-1, and experience shows you shouldn't build a launcher without designing it for specific purposes. Even for the reusable Buran orbiter, the N-1 couldn't be used without substantial modification...

"Space technology develops in a very dynamic way, and designs rapidly become outdated and inefficient or simply unsuitable for the solution of future problems. For example, the Americans had the excellent, well-tested Saturn-5 booster, but did not use it for the Space Shuttle, although in size it was suitable for it. For the SDI program, they are also examining other designs for heavy-lift launchers. That's why the development of the powerful Energiya booster by V. P. Glushko and B. I. Gubanov, in my opinion, is not a manifestation of their individual personalities at the expense of state interests. That space technology is creating a solid foundation for the realization of a whole family of standardized, promising launchers like the Tsiklon and the more powerful Vulkan boosters."

Vladimir Vasilyevich Vakhnichenko, candidate of technical sciences:

"The N-1 booster, also designated the 11A52, was striking in its scale. The launch mass was almost 10 times greater than the present-day Soyuz rocket. The conical cigar with a height of 100 m and a diameter of the base 17 m was impressive. The diameter of the fairing of the L-3 craft was 6 m, and the payload occupied a third of the overall length of the launch vehicle.

"The N-1 had three stages with tandem rocket units. Between the stages were connecting framework sections through which it was easy to view the end of each unit and the number of stages. The outward appearance of the general configuration of the booster very much resembled a child's toy—a string of small spheres. The launcher's six tanks were spheres with diameters that reanged between 12.8 m and 4.9 m. Such a design was chosen because a spherical container has minimal surface area relative to volume, minimal thickness of the shell when loaded by internal pressure, the least heat increase, least thermal insulation, etc.

"However, in my opinion, those arguments did not make up for the main shortcoming: spherical containers can be configured only in a system of 'suspensionl' tanks, which, as is well known, is inferior in terms of technical efficiency to the widely employed system of 'load-bearing' fuel tanks. In the version that was accepted, we produced a structure with a double shell—in engineering terminology, 'wet' and 'dry' shells. In addition, the fabrication of tanks in six types and sizes required the development and construction of unique welding jigs and dies.

"Without a doubt, the choice of nontoxic fuel components—oxygen and kerosene—for such an enormous carrier was a far-sighted and rational decision. And although this 'composition' was explosive, the experience we had with it, the low cost, the existing production base, and, most important, the ecological cleanness of the components made such a choice justified.

"The problem of the engines themselves was somewhat more difficult to solve. The stockpile of finished liquid-fuel rocket engines that burned oxygen-kerosene fuel was unacceptable because the engines were too 'small' and were not efficient enough. A new engine was needed with a level of thrust an order of magnitude greater than that which had been attained at that time. The problem was highly complex and required design risks, a concentration of efforts, and additional time. A simpler and shorter path seemed to be the creation of a propulsion system based on several dozen liquid-fuel rocket engines. The fact that this path was pursued evidently also played a fatal role in the fate of the N-1.

"In my opinion, the refusal of the special design bureau headed by Valentin Petrovich Glushko to develop a liquid-fuel rocket engine for the N-1 launcher contributed, in large part, to the adoption of that decision. Glushko's authority was immense: not one Soviet rocket had flown without engines from that special design bureau. The rapid development of an engine with a thrust of 700-900 tons was clearly an unrealistic task for any other group. That was clearly understood by Korolev when he ordered an engine with a thrust of 150 tons from Kuznetsov.

"Why didn't the country's leading special design bureau for the development of liquid-fuel rocket engines participate in the 'lunar project'? Much has been said about the conflict between Glushko and Korolev, with emphasis on the personality and human aspects of their relationship. In that connection, I recall a conversation with Valentin Petrovich which took place in 1967 in his office in Khimki. The conversation involved the possible use in the N-1 of engines that had been developed for the Proton launcher, with a thrust of 150 tons, which he considered the most suitable for such a launch vehicle.

"This was a difficult period of time for Kuznetsov: there was one accident after another on the test stands. Glushko followed all this jealously. In the conversation, he touched on these problems and noted that he greatly doubted the possibility of setting up a stable operation in a combustion chamber of such a size with oxygen-kerosene fuel, a fuel which is dangerously explosive and is not hypergolic. It seems to me that it was precisely this lack of confidence and the unwillingness to take a risk that kept him from undertaking the development of an engine for the N-1 booster.

"This version is in good agreement with the fact that his special design bureau refused to develop single-chamber liquid-fuel rocket engines that burned oxygen and kerosene, as indicated by the four-chamber engine for the Vostok and the four-chamber engine for the Energiya.

"In discussing the fate of the N-1, it is impossible to be silent about the fact that, in the creation of the launcher, the unwritten law of rocket building was violated: that the bugs in the burn of rocket stages must be worked out on the test stand. In order to save time and money, it was decided not to construct a stand for the first stage, which meant that the crucial final tests would be shifted to the flight-test stage. The underestimation of the scale factor—the immense size of the launch vehicle, each launch of which was an event in the life of the country—played a fatal role in the erroneousness of this decision. Earlier, when smaller launch vehicles and military missiles were being developed, many ground-test 'flaws' would be eliminated during flight testing. And it was no big deal that for some rockets it was necessary to carry out 40-50 launchings before they 'learned' to fly. But that approach was unsuitable for the N-1.

"After the first accident, when the Chief Designer V. P. Mishin still hoped for a 'miracle,' the recommendations of the head institute for the 'cure' of the N-1 were unambiguous: mandatory introduction of a burn-monitoring system on the engines and stages prior to assembly as part of the launch vehicle. Better an accident on the stand than in flight. And although these recommendations were quite consistent with the experience of the Americans in developing the Saturn-5, they were rejected.

"The unsuccessful launches continued, and no miracle occurred. Listening closely to the recommendations of the institute, Kuznetsov proceeded to modernize the engine, evaluating all the advantages of reusable design. Soon the first Soviet-produced liquid-fuel rocket that was truly reusable was manufactured and underwent

firing tests. All the engines were ready for the fifth launch. But the chief designer couldn't be convinced of the need for the same kind of modernization of the stages. Our 'lunar project' had worn out its 'credibility' after four unsuccessful N-1 launches and was shut down.

"Right up to the eve of the shutdown, nobody believed that it could happen. After all, a gigantic flywheel of operations involving many thousands of groups at scientific research institutes, design bureaus and factories throughout the country had gathered momentum. At the time, it seemed more reasonable for economic reasons to finish what had been started. A heavylift launcher would open new possibilities for the development of near and deep space.

"I recall that the first reaction to the report that all operations had been shut down was the feeling that an incorrect decision had been made. People were resentful after having devoted many years to the work, groups were resentful because they had not tasted the fruits of their many years of labor, and there was lack of confidence that after such a 'flop' those who had participated in it would be assigned to a new project of similar scale. But here I was mistaken: a new project was soon assigned to virtually the same workers. It was the year 1976..."

***

[Rebrov]: And still more about this vast project. Design and engineering studies related to the booster and lunar craft were being carried out, but as early as March 1968 a program had been approved for the training of cosmonauts for flight to the Moon. In fact, training at Zvezdnyy had already begun in January. Assuming that several main crews and as many backup crews would be needed, General N. P. Kamanin gave an order that 18 persons be included in the training group.

Somewhat earlier, a trainer that simulated conditions for getting around on the Moon's surface, where gravity is one-sixth that on the Earth, appeared in the gymnasium of the Cosmonaut Training Center. At the Institute of Aviation and Space Medicine, which belongs to the Air Force, a centrifuge was used for developing skills in the manual control of a spacecraft upon reentry into the Earth's atmosphere after completion of a lunar voyage. By March 1968, the top four cosmonauts was selected: V. Bykovskiy, A. Leonov, N. Rukavishnikov, and V. Kubasov. Together with them, this author had an opportunity to work in both trainers. Korolev had the idea of sending a journalist into space as early as 1964. Back then, after receiving an "OK" from the doctors and undergoing general training, I became part of an endeavor that opened the way to a cherished dream.

The painful and even dramatic fate of the N-1 rocket formed the bases for our entire lunar program at the time. And I'm not closing the book on what has been said about the subject. But that's what you think when glancing back into the past. Failure is not the end of the world. In the late 1960s and early 1970s, there were more than a few troubles in our space program. From time to time, it even seemed that the entire idea of space flight was close to being completely discredited. We recall the death of V. Komarov and the crew of G. Dobrovolskiy, V. Volkov and V. Patsayev. We recall the skeptical sneers when we were unable execute planned dockings in orbit... All kinds of things happened. As a result, as is the custom, several leading designers were "ceremoniously retired."

Fortunately, that disease did not become chronic. The long-duration orbital stations conceived as far back as Korolev have become firmly established in space. There have already been several generations of these outposts of science. Successful tests of the Energiya and Buran have taken place. There is unbiased recognition of the many achievements. Today our main concern is to make those achievements as effective as possible with respect to the solution of both of basic-science and applied problems.

A view of our situation by an outsider is interesting:

"In the West there is nothing like it; moreover, it won't even be able to reach that level in the next 10 years. The potential payload of the Energiya is so great and the cost of putting tons of weight into orbit so small that this event marks the onset of the era of the large-scale development and use of space. Whereas the Americans are concerned for the most part with short-range, highly prestigious projects, like its Moon mission, or with experiments that border on fantasy, such as the 'Star Wars' program, Russia is moving ahead tenaciously, step by step. It is doing this in the framework of a purposeful concept, concentrating its efforts on broadening the possibilities of the use of space as a very rich source of natural resources."

Those were the words of Keith Hindley. You may or may not agree with him. But the fact that today we have a rather extensive, clearly defined, specific program for work in space for the period up to the year 2005 is an indisputable fact. But the fact that we weren't the first on the Moon is very painful to me.

After all, we could have been!

General Shabanov Denies Military Spaceplane Project

LD2402132490 Moscow World Service in English 0730 GMT 23 Feb 90

[Excerpts] [Announcer] And now question time. [passage omitted] So, here is the first question. For the last six years or so there's been much discussion in the Western specialist media, particularly American, to the effect that the Soviet Union is developing a small quick-reaction reuseable spaceplane for both civil and military purposes. Most of these ideas come from photographs taken of the recovery of the Cosmos 1614 satellite. I was always under the impression that this craft and its sisters were used to test thermal protection for the Buran space shuttle. However some experts took the view that Cosmos 1614 was a subscale replica of a spacecraft under

development, and lengthy articles continue to be written on this theme. I would like you to give a definite yes or no to the spaceplane idea. Well, that's Mr. (Ferrant's) question. Do you think you can answer it, Boris?

[Boris Belitskiy] I'm rather well familiar with the picture in question. It appeared in many Western journals covering space technology. In the secrecy that shrouded the Soviet space shuttle program at that time, I think it was quite natural for some space experts to make the assumption they made.

However, in the present climate of glasnost one of my fellow journalists has shown the picture in question to a very senior Soviet military man and asked him to comment on it. Army General Shabanov, a deputy minister of defence, emphatically denied that this was a military spaceplane prototype. He said that this was in fact a Buran test model. You're absolutely correct Mr. (Ferrant) in your interpretation of the picture. Four such models were launched in all as preparation for the real Buran's maiden flight.

The models were launched under the indices, Cosmos 1374, 1445, 1517 and 1614, the number you mentioned. The test performed covered thermal insulation during reentry, again your guess was correct, and control systems. So you see Mr. (Ferrant) the military spaceplane idea has been denied by our military authorities. I would also add that an entirely different Buran replica was used for flight tests in the atmosphere.

[Announcer] (?Now) can you tell us about that too Boris? It'll probably be of interest to Mr. (Ferrant) and other listeners who follow the Soviet space program.

[Belitskiy] This was an exact replica of Buran, except for the fact that it had aircraft turbojet engines, four of them, fitted to its tail. And naturally the termal insulation tiles were mere imitation in this case since there was no reentry into the atmosphere. The replica was made at the (Mesishchev) experimental engineering works.

The replica made 24 flights in all, providing valuable training for pilots as well as testing the performance of the craft and the automatic landing systems on the ground, which performed so well in Buran's maiden flight soon afterwards. [passage omitted]

1992 International Solar Sail Project Advocated

907Q0042 Moscow PRAVDA in Russian 6 Jan 90 2nd ed p 4

Article by V. Syromyatnikov, doctor of technical sciences, under the rubric "Science in the Modern World": "In Space—Under Sail: Science Fiction on the Drawing Board, An Unusual Competition"; first paragraph is source introduction]

[Text] **Queen Isabella five centuries ago was far-sighted enough to support the expedition of Columbus. With the discovery of the New World human civilization entered into a new stage of development. It is not impossible that in the not-too-distant future we will again see three sailing ships—the *Nina*, the *Pinta* and the *Santa Maria*—but in the ocean of space, not the Earth's.**

The "Space Sailing Regatta" idea was initiated by the American Anniversary Organizing Committee, chaired by Claus Hayes and acting within the framework of the "Columbus 500" program. The committee is proposing that space sailing ships created in the countries of Europe, Asia and America be launched in the autumn of 1992, when the 500th anniversary of the discovery of America by Columbus is celebrated. It is proposed that they be launched from high near-Earth orbit and, slowly but steadily accelerating in a spiraling trajectory, reach the environs of the Moon and, possibly, enter an interplanetary trajectory for a flight to Mars. Like 500 years ago, such a voyage could yield unexpected results and exert an influence on the development of mankind.

The organizers have formulated the main objectives of the competition as follows: 1. To test the solar sail concept. 2. To broaden the horizons of space research throughout the world. 3. To encourage scientific and technical advances. 4. To facilitate awareness of the need for development of space in the interests of all of human civilization. In addition to the enumerated objectives, we should add still another utilitarian terrestrial objective: to use the solar sail to solve urgent problems of mankind.

The idea of using sunlight pressure for space travel, validated by F. Tsander, is almost as old as the Tsiolkovskiy formula. But over the more than 30 years of development of applied cosmonautics, not one solar sail has ever been hoisted in orbit, despite the fact that the idea has always attracted the developers of space technology. There are several factors involved here, the most important of which is the complexity of the problem.

Nature has been stingy about light pressure: within the Earth's orbit, it does not exceed 1 milligram per square meter. In order to generate an appreciable "thrust," the sails must be several hectares in area. There have never been such massive structures in space. Accordingly, their construction involves risk. And until now, no one has wanted to invest money in a seemingly questionable enterprise. It may be that a modern Queen Isabella simply has not been found.

But now the project has attracted enormous attention. The time for solar sails has evidently arrived. The potential participants in the competition are supported by many leading aerospace powers and well-known industrial corporations in the United States. Europe is represented by groups of universities and companies from Italy, France, Switzerland and Great Britain. The Asian "space" countries—Japan, China and India—have decided to test their strength a little. Among the four potential participants from our country is a creative team called the "Kosmicheskaya regata" [Space

Regatta]. It comes from the Energiya youth center in Kaliningrad, Moscow Oblast (Lenin Street, No 4).

The nucleus of this creative team is made up of veterans of the space program who began their engineering careers under the supervision of S. P. Korolev, plus younger engineers. Based on organizational principles and an unaccustomed form of cooperation, they began a search for financial and program sponsors. They had to use their brains as well as their feet. In the initial stage, the project was supported by a number of organizations of the space, aviation and electronics industries and other sectors.

Work on the technical proposals first of all confirmed that the creation of a solar-sail craft is a complex scientific and technical undertaking. It involves three fundamental problems: deployment of a sail with an area of 2-4 hectares, adherence to a very rigorous weight limit (500 kg), and continuous in-flight control of such a sail by altering its position to face the sun.

Only after all three problems are solved is it possible, after an ordinary rocket puts a solar-sail craft into an initial near-Earth orbit, to achieve acceleration of about 0.5 mm/s/s, first pointing "the stern toward the solar wind," then "going on a port or starboard tack," then moving the sail forward to meet the "wind" head-on. And continue in this manner over the course of two or three years.

How to solve all these problems in detail is not a subject for a newspaper article. I will only mention that we decided to design the solar-sail craftt in the form of two annular sails rotating in different directions. That will make it possible to use centrifugal forces for deploying the sails and maintaining their shape, and also for ensuring effective control of the solar-sail craft, because such a rotating configuration constitutes an unusually large dual "gyroscope." In general, however, I can say that the technical proposals that have been developed have indicated the feasibility of the project and the possibility of executing the formulated task within the stipulated time frame.

I should add that the competition organizers were not only thinking about technical progress, but were also striving to give an additional impetus to creativity (to include the humanitarian sphere), to attract and activate youth, and to initiate and realize new ideas. As a result, in addition to the technical and organizational-financial proposals, plans have been drawn up for social and historical measures that are to be carried out between now and 1992, during the prelaunch period, and after the space sailing race begins.

In particular, it is proposed that thought be given to ways of using the impending unusual flight for carrying out additional experiments and individual competitions. Particularly prominent is a section which it is necessary to devote to innovative ideas on the use of the project in the humanitarian and social sphere. In this connection, the idea has come up on how to embellish the year 1992 and make it brighter. Indeed, during that year, designated the International Space Year by the UN, we will celebrate more than the discovery of America. That year will also be the 75th anniversary of Soviet rule and the 35th anniversary of the launch of the first Earth satellite.

I remember well the autumn of 1957. We were young engineers of the S. P. Korolev design bureau, and in the evenings we would go outside and, when the sky was cloudless, throw back our heads and observe the slowly moving artificial star. Perhaps those clear impressions of youth prompted the idea for an experiment—to make it so that in the autumn of 1992 it would be possible to see a bright star smaller than the moon, but emitting far more light. The experiment has been named "New Light." From an altitude of 1,000 km (perigee of the initial orbit from which the "Space Regatta" is to be launched), the sail would reflect to Earth a "sun spot" 10 kilometers in diameter. That's understood. Indeed, in order to make the sail ultralarge, ultralight, and ultramobile, it is necessary that it have a mirror surface. As a result, on a cloudless night, from a 200-m sail the illumination will be equal to the brightness of 300 so-called full moons (30 lux). With such light, it would be possible not only to organize open-air carnivals, but also to read a newspaper and take photographs. But that is only the beginning.

The prospects for the use of orbital solar reflectors are virtually unlimited. Solar reflectors could illuminate cities at nighttime. Illumination from space would be even more useful for transpolar and subpolar regions and would also be important for disaster areas. It is easy to calculate the economic savings from the use of reflectors and also the savings of resources, especially electric power. In addition, it does not require any expenditures for the construction of ground structures. Still another very important property which is exceedingly urgent today is the ecological cleanness of this technology.

As the equipment and technology involved in space reflectors are developed and improved, new horizons will open up for their use. A further increase in size would enable the creation of illumination on a solar scale, which would make it possible to increase entire regions' agricultural productivity. A new export "product" is forming in the field of foreign economic relations—the delivery of sunlight from space. Thus, the new technology could exert an influence on many spheres of human activity. One would hope that with time, rockets with a payload useful for mankind will be performing patrol duty and will take the place of live missiles.

Stars have always adorned the night sky, attracting romantics, astronomers and navigators. The time of artificial stars is coming, and they will be able to illuminate the way for the scientific-technical progress of mankind, without damming rivers or exhausting the resources of the Earth's interior.

For the time being, we are only at the beginning of a long journey. The next stage is detailed development, construction, and testing. That takes money. We are searching for a Queen Isabella!

'Priroda' Module To Be Launched For 1992 International Space Year

LD1003110990 Moscow TASS International Service in Russian 2239 GMT 9 Mar 90

[Excerpt] UN, 10 March (TASS)—A session of the Scientific and Technical Subcommittee of the UN Committee on the Peaceful Uses of Outer Space ended on 9 March at the UN Headquarters in New York. Those present devoted considerable attention to preparations for the International Year of Space in 1992. In this connection, the Soviet delegation presented a wide-ranging program for cooperation with a number of countries.

Specificially, the Soviet Union proposes to launch a special module, "Priroda" [Nature], and to dock it with the "Mir" manned space station. The module will be equipped with apparatus for studying the terrestrial atmosphere and its pollution, the state of the World Ocean and water pollution, and the processes from which cyclones originate, and for studying the planet's forests. It is also intended to conduct on board the "Mir" space station in 1991-92 scientific experiments devised by young scientists and students in the developing countries, and also to carry out space photography of the territory of several developing states (two-three in each region) and to hand over to them, free of charge, the material obtained. The USSR's proposal to launch space devices belonging to other countries and to international organizations on mutually acceptable terms is also an important direction of cooperation in space. [passage omitted].

Omsk Production Association 'Polet' Declassified

90UM0227A Moscow PRAVDA in Russian 16 Jan 90 Second Edition p 8

[Article by PRAVDA correspondent Yu. Shpakov: "Top Secret!: Polet Flies High"; first paragraph is PRAVDA introduction]

[Text] Glasnost can bring quite a surprise at times! All of a sudden commonly-known, reference-type facts combine with closely-guarded secrets to present your native city in a new light and endow old acquaintances with a new nature.

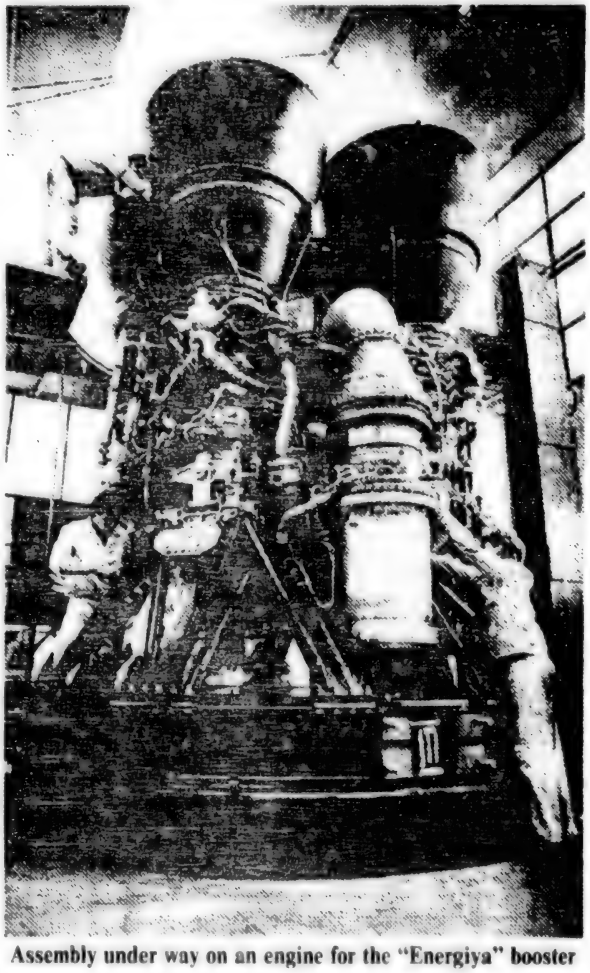
Operating in Omsk for almost half a century is an enterprise until recently completely closed to the press. There is a collective of many thousands—and at the same time it's as if it didn't exist. Bound by their written promise not to divulge classified information, the people working at the enormous plant lived in their isolated little world. Some people that worked many years in the same shop were not aware of the nature of the work until the very end.

Today we can speak of things using their real names. When the war broke out, two Moscow aviation plants were evacuated to Siberia and merged into one plant. Shortly thereafter, buildings were erected in the outskirts of Omsk, where production of high-speed bombers, supervised by A. N. Tupolev, was initiated; Yak-9 fighters were to follow. It is interesting to note that the first director of the Omsk plant was famous pilot A. Lyapidevskiy, a participant in the Chelyuskin episode and one of the first Heroes of the Soviet Union. Working as deputy chief of one of the shops was S. Korolev, the future general designer.

In the 1970s the enterprise took on the name "Polet" Production Association. It also changed its area of specialization—from aircraft to space rockets. This constituted a radically new phase of the collective's life, which was rich in history and traditions.

In the company of V. Chumachenko, a Department Chief at the Association, I walked through shops that had never been seen by a reporter. I cannot say that everything I saw struck me as being new, since some similar things had been shown a number of times on television and in newspaper and magazine photos. Nevertheless, it is one thing to look at a photograph and another to stand in front of items that previously were inaccessible.

It turned out that units such as those being assembled on the test stands there had lifted the superpowerful Energiya booster into orbit. Those elegant, smartly-painted rockets are twins of those that carry communications and navigation satellites into space. Spacecraft themselves, packed in banks of solar batteries, are also designed and manufactured here, in Omsk.



Assembly under way on an engine for the "Energiya" booster

"One of the more notable developments is the international system Kospas-Sarsat, which was brought into being in creative collaboration with American, French, and Canadian scientists," said association Chief Designer, Doctor of Technical Sciences A. Klinyshkov. "It is designed to rescue ships and aircraft in distress. Two Soviet and two American satellites track transport craft that are provided with locator beacons capable of determining the coordinates of an area in which an accident has occurred. The system, which has been operating for several years, has been instrumental in saving a number of lives. With this navigation satellite as a basis and the use of newly developed models, it is planned to create a global communications system that will be of service to geologists, railway workers, medical personnel, atomic industry workers, and others. But consider this interesting aspect."

Aleksandr Semenovich showed me a document which discussed the possibility of employing satellite systems to track railroad refrigerator cars. First Deputy Minister of Railways G. Fadeyev stated an unusual resolution: "It if were possible to complete this work in our lifetime, this would be the best kind of memorial to us."

The idea evidently bordered on the fantastic to the mind of the experienced manager, since he mentioned a highly indefinite time frame. Nevertheless, the Omsk people do not intend to drag out this task. Initial testing has already been carried out.

It is hardly necessary to point out the enormous savings that would be obtained on a country-wide basis if all perishable products shipped by rail (and, in principle, by any other carrier) could be kept under vigilant surveillance. In Polet, 1991 is confidently cited as the year when the system will be implemented. It seems that the wait will be short.

The Siberian designers are ever more confidently dealing with international orbits. For example, they are competing in developments associated with UNESCO and looking into the organization of satellite communications for application to earthquake prediction. Only a short time ago such activities would have been looked upon as exercises offering no practical value. The situation has changed, however. There is now a powerful element at play: conversion.

"Conversion, in our understanding, is primarily the effective utilization of the accumulation of the enormous scientific, technical, and intellectual resources for promoting high humanitarian purposes," said V. Zaytsev, general director of the GPO Mashinostroitel of PO Polet, and Hero of Socialist Labor. Since conversion caught us unawares, we at first had to operate by applying local initiative. The shops were offered their choice of a product, after which unoccupied production facilities were utilized to manufacture 'a thousand little articles.' However, in the future we will become involved in more sizable matters—ones more in line with the collective's capabilities."

Strictly speaking, highly popular consumer goods have been in production there for some time. That is why the semiautomatic washing machine "Sibir-6" is rightly considered to be the best in the country: It is inexpensive, convenient to use, and reliable. No wonder that supply cannot keep up with the demand. Negotiations are being held with a large foreign firm; the purpose is to organize a joint enterprise that would manufacture automatic washing machines capable of competing on the world market.

Among the new products nearing completion at Polet is an automated line for baking 1,100 eclairs an hour. In one of the shops I was shown a model developed by Ukrainian food machinery designers and the Siberian version of the same line. The difference in quality was amazing.

"We are rocket people," smiled Assistant Shop Chief Yu. Bobkov. "We simply do not know how to do sloppy work."

The association has other orders for food industry machinery: lines for producing shortcakes and chocolate bars. Each one is capable of manufacturing one ton of confection per hour. In essence these are miniplants, and their mastery requires quite a bit of effort. All the more since there are no comparable domestic models in existence. None of this may be inspiring, but someone has to bring our long-suffering food industry out of its sleepy backwardness!

A. Klyusov and M. Kamenskiy, assemblers of light-class rockets

The collective's difficulties and unresolved tasks abound. Aviators would say that you must quickly vary your wing geometry while maintaining altitude. However, the extremely rich experience and high quality of production guarantee that Polet will withstand the trials presented by conversion.

May it have clear skies!

History of Kaliningrad Space Design Bureau

907Q0028 Moscow TRUD in Russian 22 Nov 89 p 4

[Article by TRUD special correspondent V. Golovachev, Kaliningrad, Moscow Oblast: "Rocket Center Reveals Secrets: Little-Known Pages From the History of the Space Program"]

[Text] Once (it was in 1965), I made arrangements with Chief Spacecraft Designer Sergey Pavlovich Korolev to stop by and give him an article for his perusal.

"Come on over," said Korolev. "You know—(he was silent for a second)—getting in here is rather difficult. Let's do it this way. You know where we are located?"

"Yes, in the Podlipki area."

We were talking on a "vertushka," a government communications line that virtually precluded any eavesdropping. But yet, I got the feeling that, even on this telephone, Korolev was speaking with caution—for many decades he had been surrounded by an atmosphere of the strictest secrecy, and, as we know, even his last name was a secret in those days.

"OK, drive up the road that is familiar to you," Korolev explained. "When you reach our area, there'll be is a fork in the road. Don't turn right, just continue straight ahead for about half a kilometer. There will be an iron gate on the right, in a brick wall. Drive up to it, and it will open automatically. After you pass through, the gate will close. (I later learned that this entrance for important visitors is called the "mousetrap."—V. G.). Inside there is a lobby, and someone will come from there to get the article...."

More than 20 years have passed since them. During all those years, the "taboo" remained on entry into the "secret rocket center," the name used in the West to refer to the complex in Kaliningrad, near Moscow. And now finally, it was lifted. You can imagine the enthusiasm the group of accredited reporters from central newspapers, radio and television had as they became acquainted with this truly unique center and its history.

It's 1945. In defeated Germany, the secret services of the allies, unbeknownst to one another, are conducting an intensive search for anything related to the two most important military secrets of the Reich: the work dealing with development of powerful rockets, and that of an atomic bomb project. The father of the German V rockets, Werner von Braun, and a group of designers and engineers, surrendered themselves to the Americans. Our specialists (S. P. Korolev and others) were studying the German rocket center in Peenemunde on the Baltic Sea islands, which had been taken by Soviet troops on 5 May 1945. After the end of the war, the A-4 (V-2) rockets and their systems were transported to the United States, England, and France and—parts of them—to the USSR.

Work on rockets began in Podlipki, near Moscow, right after the war. In 1946, a third section was established here, at a large artillery plant that had manufactured anti-aircraft guns and tank and antitank cannons. At first, it had only 52 engineers and a few blue-collar workers, headed by S. P. Korolev.

The first long-range ballistic missile was launched in the USSR on 18 October 1947. It was, in essence, a German V-2. That doesn't in any way belittle our achievements in rocket-building. For, after reproducing the V rocket in order to make sure of our capabilities, we then proceeded along our own route and, in just a year's time, developed a completely different rocket, which was launched on 10 October 1948.

Quite a bit was written in the foreign press to the effect that the first Soviet rockets had been developed with the help of former Reich specialists; supposedly, they provided promising developments, which resulted in the rapid progress of the new technology in the USSR. Our silence on that score was perceived, not infrequently, as a lack of proof to the contrary. But it is time to lift the curtain.

Yes, German rocket specialists did work in the USSR. In 1947, they were quartered in Podlipki (to this day, the unusual wooden homes they built with pointed roofs still stand). That same year, all of them (177 people) were transferred to a branch where they continued to work on a new rocket that was to be more refined.

Concurrently, work proceeded in Podlipki. The first flight tests of our second R-2 rocket (September 1949) revealed that the designs of Soviet specialists (in particular, the separating nose-section) and the route they chose were preferable. In 1951, all of the secret work at "Branch No. 1" was stopped, and the German specialists were sent back to Germany. That same year, the R-2 rocket was adopted in our country as armament. Series production was assigned to another plant, specially built for that purpose.

In Podlipki, they went beyond that and developed new long-range rockets, including the powerful R-5 with a nuclear warhead (1953), the first intercontinental two-stage R-7 (1957), and then a more powerful intercontinental missile (1962)....

As we know, rockets can be used both for military purposes and for peacetime research and exploration of space. S. P. Korolev was passionately interested in the latter direction. In time, it became the principal direction of the OKB-1 [special design office] in Podlipki. New space firms appeared and began an independent existence, and many of them left Podlipki.

S. P. Korolev, who passed away during surgery in January 1966, ran the rocket-and-space center for almost 20 years. Sergey Pavlovich was succeeded by his first deputy, V. P. Mishin. However, eight years later, in 1974, the country's best specialist in rocket engines, V. P. Glushko, was named general designer. Since 1989, the general designer of the "Energiya" research-production association (which is the present name of that organization) has been Yu. P. Semenov, who has worked there for a long time and, 20 years ago, was appointed the leading designer of spacecraft for missions to the moon.

Yes, we had our own program which called first for flights around the moon and then a moon landing. A. A. Leonov, N. N. Rukavishnikov, V. F. Bykovskiy, and O. G. Makarov were preparing for it. And, at the first stage, it appeared that things were advancing....

In the plant's museum we saw a machine that returned on 21 September 1968 after flying around the moon. It was the Zond-5. Essentially, it is a two-man spacecraft. Its initial mass was over 5 tons. Our spacecraft was the first in the world to fly around the moon and return safely to earth, making a splashdown in the Indian Ocean. There were turtles in the cabin, and they withstood the flight very well.

Two months later, another craft of ours, Zond-6, also flew around the moon and, upon returning, landed in the USSR. In theory, we could probably now send cosmonauts to Selene. But in December, American astronauts flew around the moon, and six months they later landed on it.

Our unmanned craft flew another two times around the moon and returned to earth. But, for reasons of prestige (why fly to the Moon, people said, after the Americans have already landed on it) and after lunar soil was delivered to Earth by the Soviet Luna-16 station, the lunar program was gradually shelved.

We had been developing the powerful N-1 rocket for a lunar landing. It was to insert a 95-ton payload into orbit. When in 1974, after four unsuccessful launches, the rocket was close to being ready and everyone thought that the N-1 would soon "go," work on it was stopped unexpectedly. The assembled rockets were never even launched. Having "shut down" the N-1, we began work on development of "Energiya." In the opinion of a number of specialists, we lost more than 10 years and many billions of rubles because of that.... Others, however, believe that the funds spent on developing the N-1 were not wasted and that much of what was done in those years was useful in the development of Energiya.

Today, however, another question arises: very well, the money has already been spent, and the Energiya rocket has been developed—so what should be its cargo? After all, there has to be a return on our funds.... Specialists are proposing a solution: to put powerful platforms, 18-ton communication satellites, into high-altitude stationary orbits. The idea has its advocates and its opponents. What are the "pluses"? It's possible to set up telephone communications that cover the entire country. (At present, in the Nonchernozem region alone, there are 20,000 settlements with no telephones at all. And how many more such settlements are there in Siberia, Kazakhstan and the Far East?)

We could have portable personal telephones that connect subscribers no matter where they are: one, for example, could be in a forest, the other on a train. Public telephones aboard aircraft and ships, on trains and intercity buses. It would mean new horizons for television broadcasting—a satellite can relay 320 programs. The programs can be relayed directly to collective-use antennas installed on a building or in a mountain village....

What about the "minuses"? If such a satellite were to be destroyed in a failed launch or in orbit (in the event of, say, depressurization), the loss would be much greater than from the loss of an ordinary communications satellite. Another objection: where are we going to get that many telephones, that much wiring, that many cables, that many antennas, etc.? Our country is not ready for such a level of civilization....

Here we could give some weighty counterarguments, but I shall limit myself only to the question of economics. Two large satellites replace 32 small ones, and profitability is twice as high with the large ones. Also, how are you going to fit 32 satellites in the "densely populated" stationary orbit? That's not so simple, either.

It has been estimated that 60 billion rubles and many decades will be needed for 60 million new telephones. Large communication satellites would solve the problem in an immeasurably faster time and at a lower cost.

American rockets cannot, at present, put such satellites into space, but our Energiya can. That means that we could use a space platform for international communications, leasing out the channels and receiving currency in exchange.

But initial allocations are needed for that. Of course, the sums are not small—four billion rubles for the entire program. However, after it begins operation, all of the expenses would be reimbursed within a short time, and the communications satellites would start making a sizable profit. The specialists would have to analyze all the variations and come up with the best design. But our voice, the voice of the taxpayers, is of no small importance today.

Taking shape on the jigs of the space plant are vehicles, units, and assemblies that are slated to fly next year and in 1991. Work is being done with Buran, the unmanned launch of which is scheduled for some time in the first half of 1991. That same year, three international crews, with cosmonauts from Japan, Great Britain and Austria, will go aloft (aboard ordinary spacecraft). And in 1992, there may be missions with cosmonauts from FRG and France....

At present, the Energiya association is actively expanding the spin-off process. It is producing consumer goods (for example, more than 5 million Minutka pressure cookers have been manufactured since 1971, including 665,000 [or 965,000—source illegible] for export); unique materials and technologies, which were developed for Buran and other vehicles, are being transferred to various sectors of the national economy. The NPO [scientific-production association] is preparing to produce modern kitchen appliances and equipment.

But, perhaps the most important thing is the manufacture of highly effective prostheses, which millions of our citizens need at the present time.

Energiya will not only manufacture the prostheses, but will also fit to people individually in its own shop.

Thus, terrestrial and space problems have converged here, and this represents one of the bright spots of our times.

Journalists Disappointed About Space Flight Plans

LD2702185790 Moscow World Service in Russian 1040 GMT 27 Feb 90

[From the "Soviet Chronicle" feature of the "Soviet Union Day by Day" program]

[Text] Many Soviet journalists are disappointed with the unwillingness of the leaders of space departments to send one of their colleagues on a space flight. Their complaints were discussed at a roundtable session of editors of the central newspapers and recognized authorities from the Soviet space program. Leonind Gorshkov, a leading specialist in the Energiya firm said that it is virtually impossible to train a journalist for the flight in six months and it is risky to send one as a passenger. For their part, the journalists recalled that the country's leadership voiced a positive attitude to this project and that the training could have started long ago.

Journalist Candidates for Space Flight Aboard Mir Named

LD0103195290 Moscow TASS in English 2000 GMT 28 Feb 90

[Text] Moscow February 28 TASS—The first Soviet journalists—candidates for a mission aboard the Mir orbital complex—were named here today. A panel of medical experts at the USSR Health Ministry's Institute of Medical and Biological Problems found Svetlana Omelchenko of Moscow's VOZDUSHNY TRANSPORT (Air Transport) newspaper and Pavel Mukhortov of Riga's SOVETSKAYA MOLODEZH (Soviet Youth) newspaper the fittest. They have been admitted to a special training course in the cosmonaut training center outside Moscow.

"As regards our institute", Soviet physician-cosmonaut Valeriy Polyakov, who is now deputy director of the Institute of Medical and Biological Problems, told TASS, "we approached the issue of preparing a press representative for a space mission in full seriousness and with a sense of utmost responsibility. We did all in our power to select those from the great number of applicants who can actually withstand the extreme space conditions—naturally, after an appropriate preparation in the Cosmonaut Training Center. Personally I wish with all my heart to see a representative of the journalist legion effectively and highly-professionally reporting from the orbit".

Soon, an institute spokesman told TASS, some more journalists will complete a comprehensive set of medical examination. Then a complete list of candidates for pre-flight training will be published. The final selection is expected to be made by the Chief Medical Commission and the Space Commission of the USSR Journalists' Union.

'Ethical Problems' of Mixed Space Crews

LD1304095590 Moscow TASS in English 0847 GMT 13 Apr 90

[By TASS correspondent Rena Kuznetsova]

[Text] Moscow April 13 TASS—Although the Soviet Union was the first nation to launch a woman into outer space, the Soviet space program in the past few years has included flights by only all-men crews.

After the flights of Valentina Tereshkova in 1963 and two flights by Svetlana Savitskaya in 1982 and 1984, no Soviet woman has set foot in space.

At the same time, the United States space program regularly involves flights by mixed crews.

Aleksandr Aleksandrov, head of the Soviet Civil Cosmonauts' Training Program, explains the absence of women in Soviet space crews by referring to the demanding nature of space expeditions' programs. Above all, this refers to work during space walks, he told TASS.

"This is unbelievably hard work even for men," says Aleksandrov, who himself participated in two space flights.

"Practically every expedition now involves space walks. Aleksandr Viktorenko and Aleksandr Serebrov walked into space five times during their expedition to the Mir orbital station, spending a total of 17 hours 36 minutes there," he said.

Aleksandrov does not rule out the participation of women experts in short-term expeditions, as is practised by the United States. But, he said, the long-term stay of men and women in orbit "brings about moral and ethical problems."

He said specialists discussed the possibility of launching a husband and wife into space, but failed to find a couple.

'Zenit' Launchers To Be Used at Australian Commercial Spaceport

907Q0052A Moscow RABOCHAYA TRIBUNA in Russian 27 Feb 90 p 3

[Article by S. Sadoshenko, special correspondent, Dnepropetrovsk: "'Zenit' Will Fly From Australia"]

A preliminary agreement has been reached between USSR Glavkosmos and Australian businessmen concerning commercial launches of Earth satellites by Soviet "Zenit" booster rockets from a cosmodrome on the Cape York Peninsula.

"Zenit" was created at the Dnepropetrovsk NPO "Yuzhnoye" (Southern). It is a medium-class rocket with a launch weight of about 445 tons. Its height is 57 meters; maximum diameter of the rocket body is 3.9 meters.

These figures can say a great deal to specialists. By the way, the specialists already are familiar with the "Zenit." It went into operation in 1988 and in May of last year it was presented in Bonn at the Second European Conference on Aerospace Technology which discussed achievements in the area of creating space transportation systems. The Dnepropetrovsk booster was rated quite highly.

In the first place, with respect to the ecology it is preferable to the Titan-34D (U.S.), the Ariane-4 (EEC) or the Long March 3 (China) which are being offered in the international market. In the second place, it is more accurate.

For these reasons, as well as its other advantages, the Soviet rocket could be a successful item in the international market for space transport systems. It should be added that the "Zenit" also has the capacity to orbit a piloted spacecraft. So the Australians, of course, haven't miscalculated here.

Agreement Signed on West German Flight to Mir in 1992

LD1804122490 Moscow TASS in English 1130 GMT 18 Apr 90

[By TASS correspondent Oleg Grigoryev]

[Text] Moscow April 18 TASS—The Soviet Union and West Germany have reached agreement on a joint space flight on board the Soviet orbital Mir station in 1992. It will last eight days, including six days on the station.

The agreement was signed today between the Licensintorg Foreign Economic Association, representing the interests of the key Soviet piloted space flights association Energia and the German Avaiation and Astronautics Research Institution (DLR).

The project will be carried out on commercial lines. It envisages a wide range of joint material studies and biomedical experiments in conditions of microgravitation. Soviet experts will help their West German colleagues prepare and carry out the experiments, detailed programs for which will be drawn up during the flight preparations.

The results of the experiments, received by West German cosmonauts and including various materials, records or videodata, weighing up to 10 kilograms, will be delivered to the earth after the joint orbital flight.

The agreement envisages the work of specialists from both countries in the USSR and the FRG, regular information of the public about the project's implementation and possible joint advertising campaigns, devoted to the flight.

END OF FICHE

DATE FILMED

2 July 1990